

Dr. Duncan French: How to Exercise for Strength Gains & Hormone Optimization | Huberman Lab #45

In this episode, I talk to Dr. Duncan French, Ph.D., the Vice President of Performance at the UFC Performance Institute and a world-class performance specialist. We discuss specific resistance (weight) training regimens for increasing testosterone in men and women and how to vary mechanical loads and rest between sets and workouts to optimize hormone output and training results. We also discuss how stress-induced "catecholamines" can increase testosterone or decrease it, depending on duration and mindset. And we discuss specific cold- and heat- therapies for increasing resilience, reducing inflammation, heat shock proteins and more. We discuss nutrition for training and how to match nutrition to training goals and metabolic flexibility. We discuss mental focus and how long to train for skill development. Finally, we discuss how mixed martial arts and the UFC Performance Institute are a template for exploring human performance more generally. This episode is intended for anyone interested in athletic and mental performance: athletes, students, and recreational exercisers and includes both science and many practical tools people can apply in their own training.

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- Welcome to the Huberman Lab Podcast where we discuss science, and science-based tools for everyday life. I'm Andrew Huberman, and I'm a Professor of Neurobiology and Ophthalmology at Stanford School of Medicine. Today, I have the pleasure of introducing Dr. Duncan French as my guest on the Huberman Lab Podcast. Dr. French is the Vice President of Performance at the UFC Performance Institute, and he has over 20 years of experience working with elite, professional, and Olympic athletes. Prior to joining the UFC, French was the Director of Performance Science at the University of Notre Dame, and he has many, many quality peer-reviewed studies to his name, exploring, for instance, how the particular order of exercise, whether or not one performs endurance exercise prior to resistance training or vice versa, how that impacts performance of various movements and endurance training protocols, as well as the impact on hormones, such as testosterone, estrogen, and some of the stress hormones such as cortisol. He's also done fascinating work exploring how neurotransmitters, things like dopamine and epinephrin, also called adrenaline, can impact hormones, and how hormones can impact neurotransmitter release. What's particularly unique about Dr. French's work is that he's figured out specific training protocols that can maximize, for instance, testosterone output or reduce stress hormone output in order to maximize the effects of training in the short-term and in the longterm. So, today, you're going to learn a lot of protocols. Whether or not you're into resistance training or endurance training, you will learn, for instance, how to regulate the duration of your training and the type of training that you do in order to get the maximum benefit from that training over time. So whether or not you are somebody who just exercises recreationally for your health, whether or not you're an amateur or professional athlete, or whether or not you're just trying to maximize your health through the use of endurance and/or resistance training,

today's discussion will have a wealth of takeaways for you. There are only a handful of people working at the intersection of elite performance, mechanistic science, and that can do so in a way that leads to direct, immediately applicable protocols that anybody can benefit from. Dr. French also provides some incredibly important insights about the direction that sport and exercise

00:02:27 Roka, Helix Sleep, Headspace

are taking in the world today, and their applications towards performance and health. Before we begin, I'd like to emphasize that this podcast is separate from my teaching and research roles at Stanford. It is, however, part of my desire and effort to bring zero cost to consumer information about science and science-related tools to the general public. In keeping with that theme, I'd like to thank the sponsors of today's podcast. Our first sponsor is ROKA. ROKA makes eyeglasses and sunglasses that are of the absolute highest quality. I have spent my career working on the visual system, and I can tell you that everything about the way that ROKA eyeglasses and sunglasses were designed was with performance in mind. First of all, they're extremely lightweight so you actually forget that you're wearing them most of the time. Second of all, even if you get sweaty, if you're running or biking or it's a hot day or you're running around and just happen to be perspiring quite a lot, they don't slip off your face, which is terrific. They also have a great aesthetic and they have a lot of different styles to choose from. The clarity of the lenses is superb. I don't think there's a match for the clarity of ROKA glasses out there. And if there is, I'm not aware of it. They are absolutely crystal clear. And that's true in any environment, whether or not you're working in a dim environment or a bright environment, the clarity is unmatched. If you'd like to try ROKA eyeglasses or sunglasses, you can go to roka.com. That's R-O-K-A.com and enter the code "Huberman" to save 20% off your first order. Today's episode is also brought to us by Helix Sleep. Helix Sleep makes mattresses and pillows that are uniquely tailored to your sleep needs. All of us have unique sleep needs, and we should be sleeping on a mattress that's ideal for us. If you go to the Helix site, they have a quick two minute quiz, ask you a number of questions about whether or not you sleep on your side, your back, your stomach. Do you tend to run hot or cold, et cetera? Maybe you don't have the answers to those questions, which is fine. They'll match you to the mattress that's ideal for your sleep needs. I took that quiz and about 10 months ago I started sleeping on the

Dusk Helix mattress. That's D-U-S-K. That's the mattress that's ideal for me, and I'm sleeping better than I ever have before. So if you're interested in upgrading your mattress, go to helixsleep.com/Huberman, take their two minute sleep quiz, and they'll match you to a customized mattress and you'll get up to \$200 off all mattress orders and two free pillows. That's helixsleep.com/Huberman. Today's episode is also brought to us by Headspace. Headspace is a meditation app that's backed by 25 published studies. By now I think most people have heard about or experienced the benefits of meditation; improved focus, better sleep, reduced stress, more creativity and insight. There are just so many studies out there that support those claims. The challenge, however, is sticking to a meditation practice. And over the years, I confess there have been times when I've meditated regularly and then I stopped meditating, even though it always provides benefits for me the first time I do it and every time I do it. With the Headspace app, it makes it very easy to meditate consistently because they have different types of meditations to select from, and they come in different durations. So sometimes I only have three or four minutes to meditate. They have those sorts of meditations. They also have longer meditations of 20 minutes or more. If you want to try Headspace, you can go to headspace.com/specialoffer. And if you do that, you'll get a free one month trial with Headspace's full library of meditations that you can use in any situation. This is the best deal offered by Headspace right now.

00:05:44 Duncan's Background in Exercise Science

So, again, if you're interested, go to headspace.com/specialoffer. And now, my conversation with Dr. Duncan French. Duncan French, great to see you again. - Likewise, likewise, thank you. I don't often have many Stanford professors in the Performance Institute, so I'm really excited. - Oh, well, this place is amazing, and you have a huge role in making it what it is. The reason I'm so excited to talk with you is that you're one of these rare beasts that you have been involved in human performance and athletic performance at the collegiate level. You are obviously very involved in MMA now, in the UFC Performance Institute. And you also had the fortunate experience, I like to think, of doing a PhD in... What exactly was the PhD in? - It was exercise physiology. - Exercise physiology. So, you're familiar also with designing studies, control groups, all the sorts of things that in my opinion, anyway, are kind of lacking from the internet social media version of exercise science, which is that people throw out all sorts of ideas about

how people should be training, what they should be doing and eating and not eating and doing. And certainly, science doesn't have all the answers, but I just think it's so rare to find somebody that's at the convergence of all those different fields. And so, I have a lot of questions for you today that I'm sure the audience are going to be really interested in.

- Well, listen, I mean, I appreciate that. It's very humbling, and yeah, I've worked hard to get to where I am, but I've always tried to be authentic. And I think authenticity comes alongside academic rigor, and objectivity, and insight and knowledge base, right? At the end of the day, it's about having confidence, having expertise and being able to deliver that expertise to, in my world, to athletes. And I think, and that's what I've always tried to do. I've tried to have many strings to my bow so that I can talk with many different hats on. You know, one day I'm talking to a coach, the next day I'm talking to an athlete, the next day I'm talking to a CEO, the next day I'm talking to an academic professor. And so, I think being able to wear those different hats is certainly a skillset that I've tried to build throughout my career. And like you said, I've been blessed to work with, I think it was 36 different professional or Olympic sports last time I counted. - Amazing. - So, yeah, it's been a wild ride. It's been great. - Which of those sports was the most unusual? - I've worked with crown green bowling. - Wait, what? - Which I don't know, as an American guy, I don't know- - I've never heard of it. - How well you'd know that, but basically imagine a 20 foot by 20 foot square of turf with a small raise in the middle, i.e. the crown. So, it slopes to the edges. - Okay. - And then, you throw out a white jack, a smaller ball, and then you roll out larger balls to try and get closest to the jack. It's a very European thing, let's say. - Interesting. - But yeah, sports performance in crown green bowling, and there you go. - All right. [Duncan laughing] Wow, and then to mixed martial arts, fighters- - Absolutely, there you go. - And everything in between. So, along those lines, can you give us a little bit about your background? Where'd you start out? Where are you from originally? - Yeah, I'm from the northeast of England. So I'm from a town called Harrogate, which is in Yorkshire, which is a northern kind of area of the UK- - Nice sunny weather all year long? - Yeah, you can imagine. Yeah, with the two weeks of summer that we get, you know? [Duncan laughs] But yeah, I mean, I did my undergraduate studies there in sports science. I did teacher training to be a physical education teacher after that. Like most people I then worked as a high school physical education teacher. You know, great experience working with kids, developing athletic qualities. But something in the back of my mind always, I wanted more, I wanted to be at the higher end of elite sport. I was a failed athlete like many people. I represented my country in

different sports and things, but I never made it professionally. So, that little seed was sown and as much as I then started to reach out to different areas to do a PhD, whether it was in the UK or also, chance my arm, took a punt, see if I could get over to the states. I mean, all my buddies were going on gap years after they finish university or whatever, and going to Bali and hanging out or whatever, traveling through Thailand. And I figured, well, I've always loved the states and can I go and kill two birds with one stone and do something academic, continue my studies, but also do it in a different environment and get some life experience. And many, many rejections, as I'm sure you kind of aware from different professors, whether it was Roger Noecker or William Kramer- - So you wrote to these folks? - I just cold called and send out information and saying, "Yeah, so have you got any opportunities?" Pushed back from them all, but dogged and kept asking, and yeah, Dr. William Kramer, who was at Ball State University in Indiana at the time, a muscle neuroendocrinologist and researcher in muscle physiology using resistance training, he basically said, listen, I can guarantee your funding for the first year of your studies, but not the next three. - Sounds like a typical academic response. - Yeah. - I can take care of you, but not that well necessarily. - Right. - Right, yeah. - Yeah, so, I spoke to my parents and said, "Hey, can we take a punt?" And they were great in supporting me. And yeah, long story short, came out to begin my PhD at Ball State. After a year, Dr. Kramer transferred to UConn, Connecticut, in Storrs, in the Northeast there. And I transferred with him and yeah, four great years with my PhD and getting my PhD with a really prolific research group that looked at neuroendocrinology, hormonal work, but using a resistance training primarily as an exercise stressor as a major mechanism, and then looking at all the different physiologies off the back of resistance training. - Yeah, you guys were enormously productive. I found dozens of papers on how weight training impacts hormones and your name is on all of 'em. And it's remarkable.

00:11:45 How Certain Exercises Increase Testosterone

I have a question about this. I'll just inject a question about weight training and hormones. You hear this all the time that doing these big, heavy compound movements or resistance training increases androgens, things like testosterone, DHT, DHEA, and so forth. Does anyone know how that actually happens? Like what is it about engaging motor neurons under heavy loads sends a signal to the endocrine system, "Hey, release testosterone." I've never actually been able to find that in a textbook. - [Duncan] Yeah,

well, I mean- - And how can I do more of that? [both laughing] - Yeah, as much as I know, and again, I'm digging out into the annals of Duncan French's kind of brain now, but yeah. I mean, I think it's a stress response, right? It's mechanical stress and it's metabolic stress. And these are the downstream regulation of testosterone release at the gonads comes from many different areas. My work primarily looked at catecholamines and sympathetic arousal. - So things like epinephrin, adrenaline? - Correct, yeah, epinephrin, adrenaline, and noradrenaline, how they were signaling; the signaling cascade using the HPA axis, releasing cortisol, and then looking at how that also influenced the adrenal medulla to release androgens and then signaling that at the gonads. - That raises an interesting question. So, in presumably weight training in women, people who don't have testes also it increases testosterone. - Yes, yeah. - And is that purely through the adrenals? When women lift weights, their adrenal glands release testosterone? - Absolutely. I mean, that is the only area of testosterone release for females. And yes, it's the same downstream cascade. Obviously the extent to which it happens is significantly less in females, but there's good data out there that shows females can increase their anabolic environment, their internal anabolic milieu using resistance training as a stressor. And then they get the consequent muscle tissue growth, whether it's tendon, ligament, adaptations, the beneficial consequences of resistance training, which is driven by anabolic stimuli. - Yeah, I have two questions about that. The first one is something that you mentioned, which is that the androgens, the testosterone comes from the adrenals under resistance loads in women. Is the same true in men? I mean, we hear that the testes produce testosterone when we weight train for men that have testes, but do we know whether or not it's the adrenals or the testes in men that are increasing testosterone more or both- - Yeah I think that- - A little bit from each? - The field is divided presently in as much as understanding the acute adrenergic response in terms of anabolic response to exercise in an acute phase and the exposure to a stimulus that is stress driven, which might be partly from the adrenal glands, partly from the gonads, versus a longitudinal exposure to anabolic environments, which is primarily driven by obviously the gonads and the endocrine environment from testosterone release at the gonads. So, the field is split in terms of how exercise is promoting hypertrophy, muscle tissue growth. And whether that is very much an adrenal stimuli, or if that's significant enough in these acute responses versus the longitudinal exposure to just elevated basal levels of anabolic testosterone habitual level. - So, it sounds like with most things, it's probably both. It's probably the adrenals- - Absolutely,

yeah. - And the gonads. And then you mentioned that testosterone can have enhancing effects or growth effects on tendon and ligament also. You don't often hear about that. People always think, testosterone, muscle. But testosterone has a lot of effects on other tissues that are important for performance it sounds like? - Yeah. - Yeah what's the story there? - Yeah, absolutely, I think the testosterone hormone is... I mean, listen, there's androgen receptors on neural tissue on neural axons. - Pretty much everywhere. Yeah. - Exactly, so, the binding capacity of testosterone and influence in different tissues within the body, I touched on muscle tissue, but the ligaments, the tendons, even bone to some extent, testosterone has potential to influence that in terms of removing osteopenic kind of characteristics, et cetera. So, yeah, it's a magic hormone let's say, and with many end impacts in terms of adaptation. - I definitely want to get back to your trajectory,

00:16:22 What Kind of Training Increases Testosterone & Growth Hormone?

but as long as we're on the interactions between androgens, testosterone and its derivatives and different tissues, from the work that you did as a PhD student and throughout your career, could you say that there are some general principles of training that favor testosterone production, in terms of that somebody who's not an elite athlete could use? Somebody who's already adapted to weight training somewhat, like they know the difference between a dumbbell and a barbell, and they know the various movements, they're not going to damage themselves. But once they're doing that, I mean, I've heard shorter sessions are better than longer sessions, but in rep loads, weight... Now, there's a lot of parameter space. But if you were going to throw out some of the parameters that you think are most important to pay attention to for the typical person who's trying to use weight training to build or maintain muscle. - Yeah. - Lose body fat, so body recomposition and/or stay strong and healthy for sport of a different kind. - Yeah, so the work that we obviously, I was exposed to back in my PhD, it was a double-edged sword. And as much as testosterone is really stimulated by an intensity factor and also a volume factor. Now, growth hormone is a little bit different. That's largely driven by an intensity factor alone. - Oh, really? - Correct. - I always thought the growth hormone was driven my volume, which just goes to show you. - Maybe I've got that wrong. - No, no, no, no. I think you're probably right which just goes to show you that most of what's out there on the internet- - Right, right. - Is completely... Not only is it wrong, it's usually backwards. So, no trust- - I trust my instinct. - No, trust your instinct

because I think people just make this stuff up. - Right. - Because it's very hard to measure growth hormone and testosterone. And I can't imagine most of the stuff that I see out there they're taking drips and measuring free versus bound and all this kind of stuff, but that's what you do in laboratories. - Right, yeah. - Yeah. - You look at total composition and you look at how much of that is free circulating- - Yeah. - In the system, how much is bound, and therefore biologically active bound to receptor, creating an adaptation. - Right. - But yeah, coming back to testosterone in terms of the training strategies, it's largely driven by both an intensity and a volume factor. So if you look at many of the exercise interventions that we use to try and investigate and interrogate testosterone, it was usually a six by 10 protocol. So, you're touching at about- - Six by 10 meaning? - Yeah, six sets of 10 repetitions, which is quite a large... 60 repetitions is quite a large volume for a single exercise. And that was usually pitched at about 80% intense of one repetition max intensity. - Okay, so 80% of the one rep max, six sets of 10 reps, separated by rest of like- - Two minutes. - Two minutes, which is actually pretty fast. - Yeah. - At least to me. Anytime you see these two to three minutes, when you're actually watching the clock, those two minute rest periods go by pretty fast. - By the third, fourth set you're dying for more, yeah. - Yeah. - And I think we formulated that kind of exercise protocol to really target the release of testosterone and try and drive up these anabolic environments to study the endocrine consequences. But I think that's the type of protocol that is most advantageous for driving anabolic environment. - And that was it for the workout? That was it? - Yeah, I mean, we would do that in a back squat. So, a multi-joint, challenging exercise, multi-muscle, multi-joint, 80% load of your one repetition max. And then, six by 10. We did play around with your classic German Volume Type, 10 by 10 kind of protocols, but they were just unsustainable at that 80%. The key to what we also did was we always adjusted the loads to make sure that it was 10 repetitions that were sustained. So if the load was too high and an athlete or participant had to drop the weights on the sixth repetition, we would unload the bar and make sure they completed the 10 repetitions. - I see. - Bringing me back to the point of it's an intensity and a volume derivative that is going to be most advantageous for testosterone release. - That's really interesting.

00:20:19 Intensity: Mechanical Load; Volume: Metabolic Load; Inter-set Rest Periods

And one thing that you mentioned there is especially interesting to me, which is you said

when you go from six sets of 10 repetitions to 10 sets of 10 repetitions, it's not as beneficial and might even be counterproductive. But to me, the difference between six and 10 sets is only four sets. It doesn't even sound that much. So that sort of hints at the possibility that the thresholds for going from a workout that increases testosterone to a workout that diminishes testosterone is actually a pretty narrow margin. - Yeah and I think it comes back to that intensity factor then. What we saw were that 10 by 10 protocol really sees pretty significant drop-offs in the load. And again, we're trying to stimulate with intensity, with mechanical strain through intensity, as well as metabolic strain through volume. And I think that's the paradigm that you've got to look at is that the mechanical load has to come from the actual weight on the bar, and the volume is the metabolic stimulus. How much are we driving lactate? How much you were driving glycogenolysis in terms of that type of energy system for executing a 10 by 10 protocol? And what we often saw was just a significant reduction in the intensity capabilities of an athlete to sustain that. So we shortened the volume to try and maintain the intensity. - Interesting. And you could imagine just taking very long rest, keeping the session, being a big, lazy bear in training. - Right. - I sometimes do this. I tell myself I'm going to work out for 45 minutes and then two hours later, I'm done, but not because I was huffing and puffing the whole time, but because I was training really slowly. - Right. - Is there any evidence that training slowly can offset some of the negative effects of doing a lot of volume? - Well, it's an old adage of... Two responses to your question. I mean, the first one, I would say there's a difference between 10 sets of six and six sets of 10. And I think that comes back to the volume conversation. Six sets of 10 is driving up metabolic stimulus. If you're doing 10 sets of six, you can probably take it to a higher intensity, but you're not going to get the same metabolic load. You're not going to get the same internal metabolic environment that drives the lactate release, that they will then signal further anabolic testosterone release because of the lactate in your body. That's a key consideration. The rest is often the consideration that's overlooked out there in general population, and in many sporting environments. That the rest is as important a program and variable as the load and the intensity of the load, the volume, et cetera. And yes, if you extend the volume, if you extend the duration of your rest periods, what you're ultimately doing is influencing that metabolic stimulus again. You're allowing the flushing of the body, the removal of waste products, lactate to be removed from the body, and then the metabolic environment is reduced. - So, if I understand correctly, you want to create a metabolic stress. - Absolutely. - So, the way that I've been training, slow and

lazy, is not necessarily the best way to go? I could, in theory, do a 45 or 60 minute session where I pack in more work per unit time. I'm not going to be able to quote unquote perform as well. I won't be able to lift as much. - Yep. - I might have to unweight the bar between sets or maybe even during sets if I have someone who could do that, but it sounds like that's the way to go. So, the old adage of high intensity, short duration is probably the way to go. - Correct. And in layman's terms, if the same objective, the same training goal is just muscle tissue growth, and we're not talking about maximal strength or any of those type of parameters, we're just talking about growing muscle. If there's an athlete A and they do six sets of 10 with two minutes rest, and there's athlete B that does six sets of 10 with three minute rest, athlete A will likely see the highest muscle gains. - Hm. - Muscle hypertrophy gains because of the metabolic stimulus that they're driving with the shorter rest periods. - Interesting. And for all the years that I've spent exploring exercise science and trying to get this information from the internet and various places that this is the first time it's ever been told to me clearly. So, basically I need to put my ego aside and I need to not focus so much on getting as many reps with a given weight and keep the rest restricted to about two minutes. - Yeah. - Get the work in, and then I'll derive the benefits. - I mean, you've absolutely nailed it to be honest. And again, if you think about human nature and how we approach, we're inherently lazy, right? As humans, we want to take that rest. We want to take the time out to recover and feel refreshed, but we're trying to create a training stimulus. We're trying to create a very specific stimulus internal to the body, and that is often driven by the metabolic environment at that moment in time. Now, if we allow the metabolic environment to change by extending the rest periods, we're not going to see as beneficial gains at the end of it. - Very interesting. - So, it is very much a motivational and ego thing rather than saying, "Okay, I'm going to push my loads as high as I can, and really challenge maximal strength,

00:25:25 Training Frequency & Combining Workout Goals

do fewer repetitions, take longer periods of time." It's a completely different approach to training. It's a different end goal. - Interesting. And you mentioned lactate, so it seems still a bit controversial as to what actually triggers hypertrophy. You hear about lactate buildup or people, the common language is the muscle gets torn and then repairs, but I don't know, does the muscle actually tear? - I mean microtrauma. - Okay, microtrauma. -

Yeah, disruption within the muscle tissue for sure. - Interesting. And we're talking now about non-drug assisted people- - Correct, yeah. - Whose, let's just say, let's define our terms here. That whose testosterone levels are within the range of somewhere between 300 and 1,500 or whatever, 1,200, because it does seem that athletes who take high levels of exogenous androgens can do more work and just get protein synthesis from just doing work. - Yeah. - I've seen these guys in the gym, right? The telltale signs are not that hard to spot where they're just doing a ton of volume, not necessarily moving that much weight, they're just bringing blood into the tissue. And then they're loading up on, they're eating a ton of protein, presumably 'cause they're basically in puberty part 15. - Right. - Right, they're on their 15th round of puberty where during puberty, you are a protein synthesis machine. I mean, to me, that's pretty clear about puberty. Interesting. So, and then, in terms of, because I know the audience likes to try protocols, so you described a protocol very nicely. What about day-to-day recovery? I mean, the workout that you described is intense, but short, how many days a week can the typical person do that and sustain progress? - Yeah, I mean, I think that comes back to your training age and your training history. Obviously there's a resilience and a robustness with an incremental training age. So, that's not a protocol that I would advise anyone to go out and start tomorrow. - They'll be mopping them off the gym floor. - Right, but at the same time, it's also relative, right? So 80% of your maximum at a young training age is still 80% versus I've been training 10 years, it's still 80%. But yes, the mechanical load is going to be significant, it's just more tonnage, right? But yeah, I think a protocol like that, we would look at two times a week, something that's pretty intensive like that, because again, it comes back to the point you make is that you really need to be, for want of a better term, suffering a little bit through that type of protocol, both in terms of the challenge of the load, but also being able to tolerate the metabolic stress that you're exposed to. It's a bit of a sicko feeling because of the lactate that you're driving up. So, I wouldn't promote an athlete doing that type of modality multiple, multiple times unless you are from the realms of bodybuilding. And then, you really, that's the sole purpose of what you're trying to achieve. Most athletes in most sports have diverse requirements in terms of outcomes that they're trying to achieve. They're not just targeting muscle growth. Muscle growth is a conduit to increased strength, increased power, increased speed, obviously. So, yes, trying to get a bigger cross-sectional area of a muscle means that we can produce more force into the ground or wherever it may be, if we're a locomotive athlete. But usually, sports, men and women, are not just purely seeking

muscle growth. They look for different facets of muscle endurance or maximal muscle power, muscle strength. So, then you've got to be very creative in how you build the workout. If it's a bodybuilder, absolutely they're chasing muscle growth and they're going to do so with these types of protocols, which sees high intensities and high volumes of workload on a pretty regular basis. If it's just somebody, a weekend warrior that wants to keep in shape and look good, I would say, two times a week for a really challenging workout like that, and then flex the other types of workouts within the week to have more of a volume emphasis, where you reduce the intensity and you might just look at larger rep ranges from 12 to 15 to 20. Another workout where you're looking at reducing the volume, but increasing the intensity and really trying to drive different stimulus to give you more end points of success.

00:29:35 How Stress Can Increase or Decrease Testosterone

- Mm hm, great. No, that's really informative. Along the lines of androgens and intensity. When I think intensity, I think epinephrin, adrenaline. And since you have a background in catecholamines and testosterone, last time I was here at the UFC Performance Institute, we had a brief conversation, and I want to make sure I got the details right. That in the short term, and a big increase in stress hormone can lead to an increase in testosterone, like a parachute jump. - Correct. - But so, stress can promote the release of testosterone? - Yeah. - That was news to me. - Right. - We always hear about stress suppressing testosterone, stress suppressing the immune system, all these terrible things. But in the short term, you're saying it can actually increase the release of testosterone. So, I have that right? - Correct, yeah, yeah. - Okay, and so then the second question is, does my cognitive interpretation of the stressor make a difference? In other words, if I voluntarily jump out of a plane with a parachute, does it have a different effect on my testosterone than if you shove me out of the plane against my will? Well, presumably with a parachute too. - Right, I mean, so this was what all my PhD work was looking at was the exposure to a stressor, and the pre-arousal of how your body essentially prepares for that stressor, and then how it manages it throughout the exposure to the stress. And it was actually motivated from parachute jumpers. There was an older study looking at parachute jumpers into combat. And then, they were studying the cortisol, the stress response, and the epinephrin response of these parachute jumpers. So, it got us thinking about, hold on, there's certain workouts that

you do that are just, they're daunting, you know? It's like, okay, it's squat Saturday or whatever it may be. Oh my gosh, this is going to destroy me. - Or I have to talk to this person I don't want to talk to or you know, right? - Exactly, yeah. - I mean, something, or a PhD dissertation exam- - Exactly or speaking- - Or something, yeah. - Giving public speaking or whatever it may be. Now, we used an exercise, we used a resistance training protocol that these athletes knew was going to be very, very challenging. There's going to have some anxiety to doing it, they knew there were going to be some physical distress from doing it. And therefore, their mindset of how they were going to approach that was already set. So what we saw 15 minutes prior to the start of an exposure to the workout, the epinephrin, the noradrenaline, the adrenaline was already starting to prepare the body sympathetically to go into what it knew was going to be a very, very challenging workout. So, that brings you back to exercise preparation, competition for certain preparation... Preparation for certain competition, excuse me. Pre-workout routines, the use of music, all these different things that we know can now anecdotally in the gym we put into place, but the data that I presented showed that... It was a first of its kind to show that this link between epinephrine and norepinephrine release and arousal, and then consequent performance. So, force output throughout the workout was intimately linked. - So, what was the takeaway there? Is it beneficial for people to get a little stressed about the upcoming impending event? Whether or not it's a lift in the gym or whether or not it's talking to somebody that you might be intimidated to talk to, or an exam? Is the stress good for performance or is it harmful? - Yeah, and I think that's a great question. And I think I can only talk to physical exertion, which is what we were exploring. And I don't want to tread on the toes of the psychologists with flow state and these types of things, because clearly- - I think you're in the position of scientific strength on this one. - Right. - I think you have the leverage. - All right. - I mean, I have a lot of friends in that community as I'll just say as a buffer to the answer you're about to give, that there's very little science around flow, and there's very little neuroscience related to most psychological states anyway. So I think we've got a lot of degrees of freedom here. - All right, I can breathe easy. - Yeah, yeah. - Thank you for that. - Anything you like, credit Duncan, anything you dislike, send the mean comments to me. - Yeah, I think from my data, certainly, the greater the arousal, the higher the performance was from a physical exertion perspective. And I think that was the intriguing part of some of my findings were there's definitely an individual biokinetics to some of these hormonal kind of releases. And as much as those guys that had the highest androgenic response in

terms of epinephrin release, norepinephrine release also sustained force output for a longer period of the workout than those that didn't. So, the individuals that had a lower stimulus of the sympathetic arousal, let's say, certainly didn't perform as well throughout the workout. Now, the intriguing thing then becomes is okay, and I think this really segues into what we're doing here with combat athletes, with mixed martial artists. There's a philosophy, there's a paradigm now for myself in terms of the exposure, repeat exposure. You know, the more you do that challenging workout, do you get the same psychological stimulus? Do you still get the same stress response? And the assumption is unlikely. You accommodate, you become accustomed to the stress or your body will therefore adapt. And that's the classic overload principle, right? You then need to take the stressor down a different route. But I think when you look at the athletes that we work with here, it's a fist fight at the end of the day. There's nothing more stressful than that. But I think just the exposure to the rigors of training, to understand the bad positions, the bad situations, to know that they can get out of certain situations, out of certain submission holds or whatever it may be, I think that really ties in with some of my PhD work in terms of what these guys do to approach what is a really challenging sporting arena in mixed martial arts. - Yeah, it's definitely the extreme of what's possible in terms of asking does stress favor or hinder performance? Because yeah, like you said, at the end of the day, it's someone trying to hurt you as much as they possibly can within the bounds of the rules. - Right. - And you're trying to do the same. So, I find your thesis work fascinating. Were you never to be at the UFC Performance Institute, luckily they made the right choice and brought you here, but were you have never to come here, I was still fascinated by this because over and over we hear that stress is bad, stress is bad, stress is bad, but everything I read from the scientific literature is that stress and epinephrin in particular is coupled to the testosterone response to performance and to adaptation, provided it doesn't go on too long. So, unless I'm saying something that violates that. - Absolutely, I agree. - I mean, that's your work. So it's a really important and beautiful work. And I refer to it often, so I'm just glad that- - Thank you. - We could bolt that down, because I think the people need to know this, that that discomfort is beneficial.

00:36:55 Using Cold Exposure for Mindset, Anti-Inflammation, Muscle-Growth

Now, there's another side to this that I want to ask about, which is the use of cold, in

particular, things like ice baths, cold showers, or any other type of cold temperature exposure. In theory, that's stress also, it's epinephrin. And so, how should one think about the use of cold for recovery? So, if cold causes stress, then how is cold used for recovery? That's what I don't understand. And maybe you just want to share your thoughts on that. - Yeah, no, and I think it's a great question, and I think the jury is still out there, certainly, knowing some of the conversations that we've been having. But I think, when we talk about stress, it's your classic fight, flight or freeze approach. And throwing your body into a cold tub, an ice bath, or whatever it may be certainly is going to have a physiological stress response. Now, people are using that for different end goals. And again, I think that's where the narrative has to be explained. If you are using the stress specifically to manage the mindset, to use it as a specific stress stimulus, that's the same as me doing six by 10 at 80%. You're just trying to find something to disrupt the system, to do something that's very, for want of a better term, painful, discomfort, whatever. You're just finding a stressor and then being able to manage the mindset. But if you're using cold, specifically from a physiological perspective to promote redistribution of vascularity, of blood flow to different vascular areas of muscle that you feel have gone through a workout, that are damaged or whatever it may be, I think we've got to understand what that stress mechanism is. And the data, the literature is certainly still out there with respect to cryotherapy and cold baths, and some of these cold exposures in terms of what they do at the level of the muscle tissue. If that's the target, if you're trying to promote a flushing mechanism, or you're trying to promote redistribution of the blood flow, what you've got to understand is that cold is going to clamp down every part of the vascular system. And we've really got to understand how the muscle would be redistributed to areas of interest. So, I think the stress response is a real thing with respect to cold exposure. But I think the narrative around what are you using the cold for has to precede the conversation because yes, it's like putting your hand over a hot coal. That's a stress the same way as jumping in a cold bath is. - Yeah, I think most people don't realize that. You're going to get the epinephrin release from holding your hand too close to flame. - Absolutely. - And you're going to get it from getting in the ice bath. - Your body doesn't know the difference, right? Your body does not know the difference. It has a primordial kind of physiological response that it's created over millions and millions of years. And I think that that physiology is not changing. And it's fixed in a particular way right now, that it doesn't understand the difference between whether it's six by 10 doing a challenging workout over here, whether it's putting my

hands on the hot coal, whether there's a lion stood in front of me or whatever, that epinephrin response from the level of the brain down to the whole signaling cascade is the same. - Mm hm, and cold, I've heard can actually prevent some of the beneficial effects of training. That it can actually get in the way of muscle growth, et cetera. - Yeah, there's some pretty robust data out there now showing that it definitely has an influence on performance variables like strength and power in particular, but absolutely in terms of muscle hypertrophy. And there's a big kind of theme in the world of athletic performance right now, in terms of periodization of cold exposure as a recovery modality. - Interesting. - When do you use cold? Should you be using cold for recovery in periods of high training load when you're actually pursuing, it might be general preparatory work, or are actually trying to pursue muscle growth? Well, that's usually where you get the most sore. It's usually where you feel the most fatigued, but it's probably not the most beneficial approach to use an ice bath in that scenario, because you're dampening, you're dulling the mTOR pathway and the hypertrophic signaling pathway. Whereas in a competition phase where actually quality of exercise and quality of execution of skill and technical work has to be maintained, you want to throw the kitchen sink of recovery capabilities and recovery interventions in that scenario because the muscle building activity should be in the bank. That should have been done in the general preparatory work. And now you're focusing on technical execution. So, you're absolutely right. - No, it's interesting. So, if I understand correctly, if I want to maximize muscle growth or power or improvements and adaptations, then the inflammation response, the delayed onset muscle soreness, all the stuff that's uncomfortable and that we hear is so terrible is actually the stimulus for adaptation. And so, using cold in that situation might short circuit my progress. But if I'm, I don't know that I'll ever do this, but if I were to do an iron man or something, or run a marathon, under those conditions, I'm basically coming to the race, so to speak, with all the power and strength I'm going to have. And so, there, reducing inflammation is good because it's going to allow me to perform more work, essentially. - Absolutely, yeah. You have to be strategic about when you use some of these interventions. And the time when you preparing for a competition is not the appropriate time... Excuse me, is the appropriate time when you want to drive recovery and make sure that your body is optimized. When you're far away from a competition date or out of season or whatever it may be, and you're really trying to just tear up the body a little bit, to allow its natural healing and adaptation processes to take place, well, you don't want to negate that. You want the body to optimize its internal recovery and

that's how muscle growth is going to happen, so. - So interesting. - There's a time kind of consideration that you need to make with these interventions, for sure. - At the UFC Performance Center, are the fighters periodizing their cold exposure? Or are they just doing cold at will? - Well, it's not just the UFC. And again, I talk about my personal experiences with different sports. I think just education around where science is at and our understanding of concepts like the use of cold exposure for recovery, ice bath. Everyone wants to jump in an ice bath. But I think as we've stepped back and scientists have started to figure out and look at some of the data, we're now more intuitive about, well, actually that might not be the best or the most optimal approach. And I think that's any given sport. So, yes, certainly here at the UFC, we're trying to educate our athletes around appropriate timing. And it's the same with nutrition, it's the same with an ice bath intervention, it's the same with lifting weights, it's the same with going for a run or working out on the bike. There's tactics to when you do things and when you don't do things. And I think stress and cold exposure, we have to have a consideration around that as well, but it's not just MMA fighters, that's any athlete. And I think it's the best professionals, the most successful professionals do that really well. They listen, number one, they educate themselves, and then they build structure. And I think at the most elite level, we always talk about it here at the UFC, but at the most elite level, you're not necessarily training harder than anybody else. Everybody in the UFC trains hard, like everyone is training super hard, but the best athletes, the true elite levels are the ones that can do it again and again and again on a daily basis and sustain a technical output for skill development, therefore their skills can improve, or physical development, their physical attributes can improve. So that ability to reproduce on a day-to-day basis falls into a recovery conversation. Now, when is the right time to use something like an ice bath and when isn't, is part of the high-performance conversation, for sure. - So really they're scientists; they're building structure, they're figuring out variables. - Yeah. - But it sounds like the ability to do more quality work over time is one of the key variables. - I mean, it's fundamental. I mean, garbage in, garbage out. Quality in, quality out. But in our sport, I talk about mixed martial arts, it's truly a decathlon of combat. So there's so many different attributes, whether it's the grappling, whether it's the wrestling, whether it's the transition work, whether it's a standup striking. So, the different facets of a training program in this sport are significantly large compared to something like a wide receiver in football. And that's no disrespect for wide receivers, but they run routes. They're going to run a route, a passing tree, and that's all they need to do. These guys

have to be on the ground. They've got to be great on the ground. They've got to be great standing up. They've got to be great with the back against the fence. So there's so many different kind of facets to our sport. So managing the distribution of all the training components is one of the biggest challenges of mixed martial arts and the best guys get that right. They allow their body to optimize the training. And remember, why are we doing training? We're doing training for technical and tactical improvement. Now, if your body is fatigued or you just can't expose yourself to more tactical development or technical development, then you're essentially doing yourself a disservice. You're going to be behind the curve with respect to those guys

00:46:55 Skill Development

that can reproduce that day-in and day-out. - On the topic of skill development, regardless of sport, we hear all the time and it certainly is intuitive to me that the person who can focus the best will progress the fastest. But it's kind of interesting, sometimes I talk to athletes and they seem a little bit laid back about their training sometimes, and yet they obviously know how to flip the switch and they can really dial in the intensity. Do you think that there are optimal protocols for skill learning in terms of physical skill learning? Like, could it ever be parametrized like the six sets of 10 reps? And this gets to the heart of neuroplasticity, which is still, it's not a black box, but it's kind of a black box with portions of it illuminated, I like to say. But what are your thoughts on skill development? For somebody that wants to get better at sport, do you recommend a particularly long or short training session? Does intensity matter or is it just reps? - Yeah, I think, no, it's not a volume driven exercise. It's a quality driven exercise. And listen, my expertise is not in motor learning and motor skill acquisition. I tend to default to Dr. Gabriele Wulf here at UNLV for that. She's one of the leading proponents in this area. But if you look at true skill development, it is about rehearsal of accurate movement, accurate movement mechanics. And as soon as that becomes impacted by fatigue or inaccurate movement, you're now losing the motor learning, you're losing the accuracy of the skill. People can call it muscle memory or whatever they want, right? But essentially you're grooving neural axons to create movement patterns and they're situational throughout sport, right? Whether it's a Cruyff turn in soccer or a jump shot in basketball, or a forehand down the line, you can carve out that particular posture and position and skill, and you can isolate it, and you can drill it again and again and again.

Now, as soon as fatigue is influencing that repetition, it's time to stop. And the best coaches understand that. They understand that it's quality over quantity when it comes to skill acquisition. So to answer your question in a roundabout way, I would say, yes, it's shorter sessions that are very high quality. And I think the best athletes in my experience are the ones that consciously and cognitively are aware of it at every moment of the training session. They should leave the training session not necessarily just physically fatigued, but mentally fatigued because they're completely engaged in the learning process. The problem then becomes okay, if we just do lots of 30 minutes sessions, we've got to do a lot of 30 minutes sessions to get the volume exposure of the repetition and the rehearsal of this skill again and again and again. So, it's a bit of a paradox. It's a bit of a double-edged sword, but a three hour session versus a 90 minute session, we'll take the 90 minute session any day

00:50:05 Why Hard Exercise Creates Brain Fog: Role of Nutrition

when it comes to skill acquisition, because that's going to be driven by quality over quantity. - Yeah, training and skill learning is incredibly mentally fatiguing. I've often wondered why when one works out hard, whether or not it's with run or with the weights, why it's hard to think later in the day. - Right. - Yeah, there really does seem to be something to it. And I've wondered is it depletion of adrenaline, dopamine? I sometimes think it might be dopamine, and here I'm totally speculating. I don't have any data to support this, but if you hit a really hard workout or run early in the day, oftentimes the brain just doesn't want to do hard mental work. Which gives me great admiration for these athletes that are drilling their mind and body all day, every day, with breaks. But so what are your thoughts? What leads to the mental fatigue after physical performance? - Well, again, I don't want to talk out, I'm talking to the man here, you know? - Well, we're just two scientists- - Yeah, yeah. - Speculating on this point. Up until now, you've been giving us concrete peer-reviewed study based feedback on my questions. But if we were to speculate, I mean, I think this is a common occurrence. People think if I get that really good workout in in the morning, I feel better all day. - Right. - That's true, unless that workout is really intense or really long. - Yeah. - And then you just, the mind just somehow won't latch on to mental work quite as well. - I mean, just philosophically and I think coming back to this kind of stress consideration, like public speaking or taking an exam. I mean, if you have an amazing coach who is setting up training in a particular

way, it's challenging, there's a strain related to it, and I'm not talking physical strain, I'm talking figuring things out, figuring out the skill. And I think that can be stressful. Like the learning process can be stressful. So, we've touched on stress. I also think if they hit the right technique, that reward center in the brain, that dopamine shot is going to fly up there. And there's only so many times that we can get that before that becomes dampened. And I think there's an energetic piece to it. There's the fueling of the brain. There's the carbohydrate fuel in exercise that actually the strategy around how you fuel for learning and fuel for physical training is actually pretty similar. - Glucose. - Yeah, it's glucose, it's sugar at the end of the day, right? So, are you fueling accordingly around your training sessions, be that very physical, because everyone thinks, okay, I'm going to jump on a treadmill and I'm going to bang out 15 sprints at max effort, and I'm going to be dropping off and laying on the floor at the end of it. I need to refuel. Well, what about the refueling of the brain in a very demanding exercise or drilling session where you're looking at technique, that you're trying to figure out, that's very challenging for your mind to figure out the complexity of it, that still needs to be fueled or refueled afterwards. And I think that's obviously might be an area where athletes do themselves a disservice by not appropriately fueling from what might be considered to be a lower intensity session, but the cognitive challenge has been significantly high. - So, they're skill work or drill work, and it's taxing the brain. - Correct, yeah. - And they're thinking, oh, I wasn't pushing hard lifts or doing sprints, and so I can just go off into the rest of my day, but then their mind is drifting. - Yeah, I mean, I speculate. - Yeah, that sounds very reasonable. I mean, I know that here and presumably with the other athletes you've worked with, nutrition is a huge aspect of that. And I think the general public can learn a lot from athletic nutrition because at the end of the day, the general public is trying to attend to their kids, attend to their work, whether or not they're lawyers

00:53:55 Low-Carbohydrate Versus All-Macronutrient Diets on Performance

or whatever, they need to focus. Nutrition is a barbed wire topic. - Oh yeah [chuckling]. - But since we're free to do what we would do if we were just sitting in each other's offices, which is to just speculate a bit, for the typical person, do you think these low carbohydrate diets... A typical person who exercises, runs, swims, yoga, lifts weights, maybe not all those things, but some collection of those, pushes themselves to do those things and to do them well, but isn't necessarily a highly competitive athlete. Do you

think that nutrition that doesn't include a lot of glucose, doesn't include a lot of carbohydrates, is a problem or is it okay? What do you recommend for athletes? What do you recommend for typical people? - Yeah, again, disclaimer, I'm not a dietician, but I - That's okay, the dieticians don't know what to recommend to athletes either. And I say that from having spent a lot of time with the literature now, it's a complete mess. - Right, yeah. - It's like, I thought we didn't understand anything about the brain, the nutrition science stuff is all over the place. - Right. - So I think we have, again- - We have some freedom. - Large degrees of freedom. - Right, right, right. I mean, I think it comes down to metabolic efficiency. So we would never advocate a high... I never say never, okay? But we rarely advocate a high performance athlete in a high intensity intermittent sport, like MMA, being totally ketogenic or- - You do not recommend that? - No, because at the end of the day, some of those high intensity efforts usually require carbohydrate fueling for the energy that's produced at those high intensities. So, we try to navigate around that. Now, listen, there are fighters in the UFC and elsewhere, Matt Brown is a great example, who promotes the ketogenic approach and it works for him. But we look at the science and the nature of the characteristics of our sport, and we don't necessarily promote that. - Can I interrupt you real quick? What about ketones for people that are ingesting carbohydrates? This is an interesting area because people always hear ketones and they think, oh, I have to be ketogenic to benefit from taking ketones. - Right. - But there are a number of athletes and recreational athletes now as well, taking liquid or powder-based ketones,

00:56:15 Ketones & Brain Energy, Offsetting Brain Injury; Spiking Glucose During Ketosis

even though they do eat rice and oatmeal and bread and other things. So are there any known benefits of ketones, even if one is not in a state of ketosis? - So, the use of ketones that I'm primarily aware of in our sport, is after the event. In terms of the brain health with athletes that are potentially taking trauma to the brain, et cetera, and looking to maintain the fueling and the energy supply to the brain. But yes, it's probably a little bit out of my remit. So I don't want to talk on that because I'm not fully familiar with that. - Well, I've heard that ketones after head injury can provide a buffering component. - Correct. - It's not going to reverse brain damage, but it might be able to offset some of the micro-damage. - Right, so that's how we use it, just to sustain the energy supply to

the brain that might be compromised through brain trauma. So that's why we use ketones. To come back to your original question. If it's a general population then yes, I think there's a place to argue that actually being on a ketogenic diet at times, and maybe it's a cycling exercise, maybe not... I don't mean cycling a bike, I mean cycling ketosis is beneficial because I think it's going to lead to better metabolic management and metabolic efficiency, at those lower intensities where we should be fueling our metabolism with lipids and fats. Clearly the Western diet and the modern day diet is heavily driven by processed foods and carbohydrates that people become predisposed to utilization of that fuel source above lipid use, fat use, at intensities that are very low. So, some of our data with the fighters shows that as well. But I think the challenge for us is that we're working with a clientele that require high intensity bouts of effort. So, fueling appropriately is very important for that. Now, we use tactics here where we essentially have athletes on what you would say, kind of is a largely a ketogenic diet, but then we will fuel carbohydrates around training sessions. So, we'll do very timed exposure to carbohydrates. So it's not - Post-training? - Post-training, immediately pre, during, and then immediately post. And then the rest of their diets, breakfast, lunch, and dinner, are what would look like ketogenic type approaches. So we're trying to be very tactical in the exposure to maximize the intensity for the training and then return to a metabolically efficient diet, which is heavily reduced in carbohydrate because we've fueled the sessions that need it. - I'm smiling because once again, this place, the UFC Performance Center is doing things scientifically, which to me, the idea, and I'm pleased to hear that, because to me this idea that the ketogenic diet is the best and only diet or carbohydrates and low protein diets are the best diet.

00:59:13 Metabolic Efficiency, Matching Nutrition to Training, "Needs Based Eating"

It's just, it's ludicrous. - Right. - Then you mentioned metabolic efficiency. I think some people might be familiar with that term, some perhaps not, but the way I understand metabolic efficiency is that you teach the body to use fats by maybe doing long bouts of cardio, maybe lowering carbohydrates a bit. So teaching the body to tap into its fat stores for certain periods of training. And then you also teach the body to utilize carbohydrates by supplying carbohydrates immediately after training and before training. You teach the body to use ketones, and then you use them at the appropriate time, as opposed to just deciding that one of these fuel sources is good and all the others are

bad or dispensable. Do I have that correct? - You've nailed it. I mean, from Bob Seebohar, formerly of USA Triathlon, is the guy that kind of came up with the concept of metabolic efficiency, but yes, you're absolutely right. I mean, at low intensities of exercise or just day-to-day living, we shouldn't be tapping into our carbohydrate fuel sources extensively. That's for higher intensity work or the fight or flight needs of stress. If athletes or any individual has a high carbohydrate diet, they're going to start to become predisposed to utilizing that fuel source preferentially. Now, at low intensity, that can be problematic, certainly for an athlete, because if they preferentially use carbohydrate at lower intensities, when the exercise demand goes to a higher intensity, they've already exhausted their fuel stores. They can't draw upon fat because the oxidation of that fat is just too slow. So they're essentially now become fatigued because they've already utilized their carbohydrate stores. So what we try to do yes, through diet manipulation and a little bit of exercise manipulation is as you say, teach the body or train the body to preferentially use a specific fuel source; fat, obviously at lower intensities, and carbohydrate at high intensities. And we will look at specifically the crossover point between the two, tell us a lot in terms of how an athlete is ultimately, how their metabolism is working. - Well, again, I'm smiling because I love this because it's grounded in something real and scientific, which is that we have these different fuel sources. The body can adapt to use any number of them or one of them. I think most people are looking for that one pattern of eating, that one pattern of exercising that's going to be best for them or sustain them. And they often look back to the time when they felt so much better switching from one thing to the next, but the adaptation process itself is also key, right? Teaching the body. So if we were to just riff on this just a little bit further, if somebody, I'll use myself as an example, since I can only speculate what other people's current nutrition protocols are, but if somebody is eating in a particular way and they want to try this kind of periodization of nutrition, could one say, okay, for a few weeks I'm going to do more high intensity interval training and weight training, and I'm going to eat a bit more carbohydrate 'cause I'm depleting more glycogen. Then if I switch to a phase of my training where I'm doing some longer runs, maybe I'm training less, maybe I'm just working at my desk a little bit more, then I might switch to a lower carbohydrate diet. Do I have that right? And then if I'm going to enter a competition of some sort, certainly not UFC- - Right. - Or MMA of any kind to be clear, not because it isn't a wonderful sport, but because that wouldn't be good for my other profession. But if I were going to do that, then I would think about stacking carbohydrates, ketones, and

fats. Do I have that more or less right? - Yeah, you've said it eloquently. At the end of the day, you're consciously understanding what the exposure to physical exertion is, and you're flexing your day accordingly and I think that- - So, it's need-based eating. - Exactly, for want of a better term, you can call it whatever fancy terminology there is out there, but yes, it's needs-based eating, but you're very conscious and cognizant of what is my current exercise status. If I'm taking some time off, then don't gorge on the carbohydrates. We probably need to be cut, it's going to be lower intensity work, or even just habitual day-to-day walking around, doing your groceries. That doesn't require massive amounts of glycogen storage and carbohydrate fueling. So, you can potentially go more ketogenic in nature, oxidizing lipids for that fuel. If you are in a high period of high intensity training, then you have to consciously flex your diet to support that. That's not normal, you've made a change, you've elevated the demand. So, the fueling requirements for the regenerative, not only fueling the exercise, but the regenerative requirements of your body after that type of work is going to be really important as well. So, yes, take on more carbohydrates. So, I think it's consciously interpreting the nature of your diet against where you are at any moment in time. - Yeah, I like that. I think the listeners of my podcast generally are experimenters. - Right. - They are scientists of themselves, which makes me happy obviously. And I like to think that they're paying attention to the changes they're making and how they're affecting themselves. And they seem more open to trying things, provided they can do it safely, and seeing what works for them. And I'm certainly going to try some of the change up. I also am really a creature of habit. And I think that talking to you today, I realize I'm probably doing a number of things truly wrong in my training, but also that I don't tend to vary my nutrition with my training quite as much as I should. I'm just locked into a protocol.

01:05:00 Duncan's Work with Olympic Athletes, NCAA, UFC (Ultimate Fighting Championship)

We covered a number of things related to your PhD thesis work, but I cut you off early on related to your trajectory. After you finished your thesis. - Yeah. - I know you were at Notre Dame for a while. Was that your first spot after your PhD thesis? - No, no, I basically finished my PhD and I dropped into the British Olympic system for about 14 years. - Oh my, okay. - I've done three full Olympic cycles with different sports, largely as strength and conditioning coach as a practitioner. I was always working in universities

and academia alongside, in terms of continuing to publish and write and do research and teach as well. 'Cause I enjoy teaching. - That explains the huge volume of publications. - Yeah [chuckling]. - I don't think people realize all the work that goes into getting a quality peer-reviewed publication. It's not, what do they call it now on Instagram, anecdata? Where people would do something once. - Right. - They have this experience and then they put it in the world that it's a- - Yeah. - Anecdata are, I don't even know that we should call it data. So, 14 years in working with the British Olympic team. - Yeah, so whether it was GB boxing, primarily with the Beijing cycle, but also lightweight rowers and gymnastics. And for the London Olympic games, that cycle I was the lead strength and conditioning and physical performance coach for British basketball. So, GB basketball. I had about three years in the English Premier League with Newcastle United and the soccer team, and then for the Rio Olympic cycle, I was with Great Britain Tae Kwon Do. So, again, another combat sport. After I'd finished there, I kind of moved to the University of Notre Dame, where I went into more of a managerial position working across all the different technical services; medical, nutrition, strength and conditioning, sports psychology and sports science, whatever it may be, as the Director of Performance Sciences for Notre Dame athletics. And then, after about 16 months there, the UFC came knocking and they recruited me out of Notre Dame. So, it's been a great ride, and I've got lots of athletes have taught me a lot along the way, lots of coaches. Every day is a school day, I still try and keep that mentality. And in this world we call it white belt mentality. I'm a PhD, I've got 25 years of experience in high performance sport, but I still learn every single day from these people out on the mats and in the ring and it's impressive to see what they do. - Yeah, it certainly is. I got introduced to MMA just a few years ago. I think the first time I came out here was one of the first times I'd heard of MMA 'cause I was kind of in my laboratory, nose down. And it's a really interesting sport because it incorporates so many different types of movement as you said- - Right. - It's not just stand up boxing, it's not just kicking, it's ground game, everything, and I'm still learning about it.

01:08:00 Why UFC & MMA (Mixed-Martial Arts) Are So Valuable for Advancing Performance

But as you mentioned, going in with that beginner's mind, the white belt mentality, what has been the most surprising thing for you in terms of being exposed to MMA in

particular, as opposed to other sports? Like what's unique about MMA fighters, besides that they have this huge variety of tactical skills that they have to learn and perfect? - Yeah, that's a great question. I would say two things. I'm going to answer two questions. One actually reiterates what you've already said. Like the degrees of freedom in mixed martial arts are exponential, like no other sport. We've got 11 different weight classes. We have men's classes. We have women's classes. We have kickboxers, wrestlers, jujitsu fighters, judoka, karate fighters. The stylistic backgrounds are infinite. We're a weight classification sport. There's a whole issue relating to making weight and then rebounding to fight about 24 to 30 hours. Like just the variability in this sport, the considerations that you have to make are unprecedented compared to any other sport that I've worked with. And a lot of them go against and are the antithesis of what you would expect for high performance. In terms of we don't always have a very clearly defined competition schedule. Once these guys fight, they don't necessarily know when their next fight is going to be. - What's the closest spacing of a fight? - I mean, listen, I think the record is around, it's just over a month, I believe. - Oh, my goodness. - So, you know, that's a quick turnaround, but most of these guys are fighting three or four times a year, three times a year is pretty normal. The bigger fighters, maybe two times a year. But invariably, the guys don't know when that next date is going to be. So we're in this gray area of, okay, what do we do? Like, are we taking some time off? Are we just going to do some general prep work? Are we going to try and keep the knife sharpened in case I get- - I didn't realize this. In that way it's a lot like special operations. - Absolutely, you don't know when the call is going to happen. - They have to be ready at all times. There isn't this, like, let's get ready for the season. - Right, yeah. Like when I was with the British Olympic Association, I knew it was the British Open, the Spanish Open, the French Open, the European Championships, the Israeli Open, the American Open, the Canadian Open, the Olympic games. - It's a circuit in your brain. - Right, yeah. - I can tell, yeah. - You just plan like you know where all the targets are going to be. Here, it's a moving target because you might be just hanging out doing some general prep work, and then you might get a short notice fight. They give you a quick call and it's in six weeks or five weeks. And okay, I've got to ramp everything up really quickly. So, that's a real challenge in terms of just managing all these different components of a mixed martial arts alone. To come back to your question, the other thing which is truly fascinating about these individuals is just their mental resilience. And again, we've touched on it in the talk, but the ability to do what they do on a daily basis, to look at all

the different skillsets that they have to try and engage in and bring into their training. To do that and embrace the grind, embrace the process of just learning, the physical side of our sport is unprecedented. But the mental side, we have a funny saying here. We always say it's 90% mental apart from the 60% that's physical. So, it's just more and more and more. And these guys' ability to just do that on a daily basis is very impressive. Like their resilience, their internal drive and their resilience is really impressive to see. - Yeah, all the fighters I've met here have been really terrific. It's interesting every time I meet a fighter, I shouldn't be surprised when they're often very soft-spoken. - Right. - [Andrew] They're always extremely polite. - Yeah, yeah. - You know? And fighting is such a... It comes from a very primitive portion of the brain, right? But a large portion of the brain, nonetheless. - But I think that's another skill is that switch. And again, that's the recoverability piece, right? Like you cannot be Taipei or you cannot be like super charged 24 hours a day because you're going to just fry your system, right? And I think that's something else where we're really trying to manage this whole process, be it through nutritional interventions, be it through education around sleep, be it through training program management, be it through psychological interventions. You could look at fighters and say like, these guys are go, like they're red alert and they'll run through a brick wall, but actually again, their ability to turn it on and off means that they can do what they do. They can bring it down and be very normal, very polite, very accommodating.

01:12:40 Voluntarily Switching Between Different States of Arousal

- Maybe even better than most people because one of the reasons I'm obsessed with human performance, and high-performance, and people like fighters, and elite military, or even bodybuilders for that matters that they experiment. - Yeah. - They find the outer limits of what's possible. But one of the things that they have discovered, as you're describing, is this ability to toggle between high alert states and calm states. Most typical people can't do this. They see something that upsets them on the internet or something on the news or some external event pressures down on them and they're stressed for many, many days and weeks, and sometimes it goes pathological, right? And I don't say this as a criticism, it's just that most human beings, within our species, most members of our species never learn to either flip the switch or to just voluntarily toggle between states. I think athletes learn how to do that extremely well. And it sounds like MMA

fighters do that even better than perhaps many other athletes. - I mean, yeah, there's the odd one or two that would struggle with, but I think in terms of that chronic exposure, we see that coming from challenges around cyclical weight cutting, and metabolic disruption, and metabolic injury, not necessarily from the psychological drive. They do understand that this is a job for them. And the time on the mats, most of them can turn it off a little bit and downgrade things when they're off the mats. It's impressive to see, because again, like, as a layman, just looking at the fight game, you think it's going to be crazy chaotic, 100 miles an hour every hour of every day, but that's clearly not the case. They manage their energy and their efforts pretty well. - So it's a little bit like science. Although maybe scientists could take a lesson from- - Yeah, that evidence-based practice or practice-based evidence, right? - Oh, I like that. [Duncan chuckling]

01:14:30 Heat, Getting Better at Sweating, Heat Shock Proteins, Sauna

That's good. A couple more questions, I can't help myself. I know we talked about temperature earlier when we discussed cold, but I can't help myself, I have to ask you about heat. Because earlier we were having a conversation about heat adaptation, about how long does it take for the human body or athlete or typical person that's maybe exploring sauna or things of that sort to learn to be a better sweater? It sounds like something none of us would want to do. We all want to stay cool, calm and collected. But one of the reasons to deliberately expose oneself to heat is for things like growth hormone release, et cetera. We can talk about this, but a couple of questions. One, is heat exposure stress in the same way that the ice bath or cold exposure is stress? The second one is, is there any difference there that's important? And the other one is how does one get better at heat adaptation or at least what are you doing with the fighters to get them better at dealing with heat? How long does that take? So the first question, just 'cause I threw three questions at you, [Duncan chuckling] is heat stress like cold is stress? - Yeah, I think it is. And I think heat shock proteins for example, are driven by that stressful exposure to a change in environment. So, I think we do graded response in terms of heat acclimation strategies, but yes, we've touched on it earlier in the conversation. For me, heat is still a stressor. And if it's managed incorrectly, you can have detrimental responses rather than beneficial responses. - So barring like hyperthermia and death, like I mean, obviously you heat up the brain too much, people will have seizures and die, but you lose neurons. But what's the right way to acclimate

heat? Taking into account that people should check with their doctor, et cetera. We do all these disclaimers, but let's just say, I want to get better at dealing with heat, or I want to extract more benefit from heat. I mean, how many minutes a day are people typically exposing themselves to heat? How often and over what periods of time? - Yeah, so, we normally start with about 15 minutes of exposure. Now, if someone's really lacking acclimation to heat, you can do that in three, five minute efforts. Do you know what I mean? And actually take- - This is a hot sauna? - [Duncan] Yeah, hot sauna, take time to step out- - 200 degrees or something like it? - Correct, yeah. - Fahrenheit, yeah. - 200 Fahrenheit, yes. And we try to work up to 30 to 40 minutes to 45 minutes in the sauna continuous. Now, we have to understand, what's the advantage of heat acclimation for our athletes? Ultimately their ability to sweat and to lose body fluids is going to be advantageous to their weight cut process. So, their ability to make weight. It is a technique that some of these guys adopt. So, if you don't have high sweat rates, it means you're going to have to sit in the sauna for longer and longer and longer to get the same delta in sweat release. So the more acclimated you are, the more your body is thermogenically adapted, the more sweat glands you have, there's more pores, you can sweat more and therefore you'll lose that fluid quicker, and you spend less time in the sauna. So, that's why we do it, to try and promote... To limit the exposure. And it comes back to your first question, is it a stressor? It absolutely it's a stressor if you've got to spend two hours over a four hour period, two hours of it sat in a sauna. - Yeah, where the phone- - Because you just don't sweat enough. - Doesn't work, so you can't. No, I'm just kidding. - Right. - People, divorce them from their phone and that's a stressor in itself. - Right, I mean, yes, I think there's a... What we do is like anything, we build up in temperature, but we build up in volume of exposure. So, we start with 15 minutes and then we just try to add on and add on across a time. And now, for us, we kind of found about 14 sauna exposures starts to really then drive the adaptations that we're looking for. So it's not a quick fix. A heat acclimation strategy has to happen long before fight week or long before the fights. This is a process that has to begin eight to 10 weeks before the fight so that we can actually get that adaptation and that tolerance to the stressor, to the exposure of heat. - This is interesting, until today, when we were talking about this earlier, and again now, I didn't realize that, but it makes perfect sense now that I hear it, that heat adaptation is possible, that you basically can train the body to become better at cooling itself, which is what sweating is. - Yeah. - I mean, I should have known that before, but you don't see that in the textbooks and so, yeah. - I mean, listen,

it's the same as the ketogenic conversation. You're training your body to be more metabolic efficient, you're training your body to tolerate heat more, you're training your body... Like the body as an organism, as an organic system, it's hugely adaptable, it's hugely plastic. But I think the skill is understanding the whens, the whys and the whereofs in terms of changing the overload, changing the stimulus to drive specific adaptation. And philosophically that's how we go about our work here. We talk about adaptation-led programming. Now, adaptation-led programming fits into every single category, not just lifting weights or running track. It fits into nutrition. It fits into sitting in the sauna. It fits into being in a cold bath or not. It fits into so many different things because we're driven by scientific insights. And that's how we really want to go about our business. - I love it, I love this concept of adaptation-led programming and doing that, not just in the context of throwing another plate on the bar or something like that, but in every aspect of one's training and performance. And I think there's a lot here that's applicable

01:20:12 Using Rotating 12-Week Training Programs; Logging Objective & Subjective Data

to the recreational athlete, too. - Yeah. - Would you say that, what comes to mind is 12 weeks. It feels like 12 weeks is a nice block of time for someone to try something in terms of to try something new, see how they adapt, adapt, and then maybe switch to something new. I realized that it's very hard to throw a kind of pan timeframe around something, but in terms of if someone wanted to experiment with heat adaptation or experiment with cold adaptation or change up their training regimen or diet, and look at metabolic efficiency, do you think 12 weeks is a good period of time to really give something a thorough go? And gain an understanding of how well or how poorly something works for oneself? Or would you say eight is enough? Or three? - I mean, that's the how long is a piece of string kind of response, right? - Yeah. - I mean, yes, if we're just talking arbitrary numbers- - Recreational experimenter. - Yeah, like three months exposure, 12 week training strategy, 12 week intervention is more than adequate to say for 99% of things that change within the body, that physiologically adapt to a training stimulus or an overload stimulus, you're going to start to see either regression or progression, beneficial or detrimental effects within three months. Absolutely, I would say so. Now, listen, I say that in as much as we do training blocks

here that are three weeks long. - Right, well, that's because of this constraint that sometimes people suddenly have to, they get the call to fight. - Correct, yeah. So it's like super condensed. And in that scenario, we're always conscious of is their body or this individual, do they have the ability to tolerate that super overload, that super condensed exposure? Now, we might be doing that purposefully. We might be trying to do an overreaching strategy where we're really trying to damage or flex something. And I don't mean like negatively damage, but like we're trying to damage tissue to really get an adaptive response versus a more drawn out 12 week strategy, which is more coherent, more planned out, more structured in nature. But yeah, for all your listeners, I would say 12 weeks to engage in a process of trying to change and adapt your body or expose yourself to something is more than sufficient to see if it's going to be the right approach for you. And I think, the individual interpretation, it always has to be considered. And I think that's where it comes back to be a thinking man's athlete or be a thinking man's trainer, like someone that's going through exercise, you have to consciously understand where your body's at any moment in time, you know? You've got to be real with yourself. You create a journal, create a log of your training, create a log of your feelings, your subjective feedback of how you felt, your mood, your sleep. - Do your athletes do that? - Yeah, yeah. We try to promote that because again, that's part of this process, you know? It might be 12 weeks for you, but I might get the same responses in eight weeks. And I think that's another critical theme here is that we could put 15 guys on the mat and give them the same workout, and there's going to be 15 different responses to that same workout because the human organism is so complex. And in nature, it's going to adapt differently. Some people will tolerate it. Some people are going to be challenged by it. Some people have got a metabolic makeup that's going to promote it. Some people are metabolically challenged by it. There's just so many different things that we have to consider. And that's what we try to do here. It's the cross we bear is that we try to understand on an individual level how to optimize athletic performance. - I think it's terrific, and the athletes here are so fortunate to have this. And most people out there, I've certainly been trying to encourage people to learn some science and some mechanism and become scientists of their own pursuits, whether or not skill learning

01:24:07 Surprising & Unknown Aspects of The UFC and UFC Performance Institute

or athletic pursuit, et cetera. As sort of a final question, what are some things about the

UFC or something about the UFC that perhaps people don't know in terms of its overall mission or what you guys are trying to do here? I mean, I think, I've become a fan of MMA and I am more and more as time moves on. Some people might be into MMA, some people not into watching MMA, but what are some things that the UFC is interested in and doing that most people might not know about, and certainly I might not know about? - Yeah, I mean, I think, we try to be cutting edge. We try to be super progressive. We think we've got an amazing platform here, particularly at the Performance Institute to do some really cool things that can inform many different people. And that doesn't just mean the 600 or so athletes that are on our global roster. What we're trying to do is, is influence global community around optimizing human performance. So, any moment in time, we're engaging in different technologies with different vendors, different partners, exploring opportunities to learn more, share data, understand what's the best mechanisms for interpreting your body, interpreting how your body's responding to training, interpreting your nutrition or whatever it may be. We're in a really privileged position to do that. But we've also, hence you being here today, we're also trying to venture into some really cool areas of science and research that's got applicability, that you can take from high performance athletes and apply to yourself, to Joe Blow walking down the street, out there that is really interesting. And that's everything from whether it's CBD and psychedelics, through to different technologies for thermal monitoring and Bluetooth heart rate monitoring or whatever it may be, through to data management, et cetera, and anything in between. We've got some great partners on the nutrition side, on the psychology side, on the data side. And I think we always try to just push the envelope a little bit more. I think we keep our core mission with our athletes, but I think a lot of what we do, hence your podcast, an amazing platform, you do such a great job of it, that we can all learn and take from the elite and interpret how it might help us, and just in the general population. So, I think that's our north star is to provide our athletes the best integrated service of care, but we also want to influence just the global community and put the UFC at the forefront of that. - That's great, well, you guys are certainly doing it, and we can't let the cat out of the bag just yet. But the things that we're gearing up to do with my laboratory- - Yeah, I'm excited. - And the work together, hopefully we'll be able to talk about that and share that in the year to come, but we're very excited about that. And, Duncan, look, I have this filter that I use when I talk to people, academics or otherwise, which is some people, they open their mouth, and it doesn't make much difference, but when you speak, I learn so much. I'm going to take

the protocols that I've heard about today, I'm going to think about how I'm training and how I could train differently and better, how I'm eating, how I could eat differently and better for sake of performance and just in general. Thank you so much for your time, your scientific expertise, the stuff you're doing in the practical realm, it's immense. So, hopefully we can do it again. - Yes, thank you. This has been a blast. I appreciate it and yeah, keep doing what you're doing 'cause I know there's a lot of people out there that love the platform. So, thanks for the invite.

01:27:45 Conclusions, Zero-Cost Support, Sponsors, Supplements, Instagram

It's been awesome. - Oh, thank you. Thanks so much. Thank you for joining me for my conversation with Dr. Duncan French. I hope you found it as insightful and informative as I did. If you're enjoying this podcast and/or learning from it, please subscribe to our YouTube channel. Please also leave us a comment or a suggestion of a future topic or future guests that you'd like us to have on the Huberman Lab Podcast. In addition, please subscribe to our podcast on Apple and Spotify. And on Apple, you can leave us up to a five-star review. Please also check out the sponsors that we mentioned at the beginning of this episode. That's a terrific way to support this podcast. We also have a Patreon. It's patreon.com/andrewhuberman. And there you can support the podcast at any level that you like. Many previous episodes of the Huberman Lab Podcast we discuss supplements; supplements for sleep, supplements for focus and for other health benefits as well. While supplements may not be for everybody, if you're going to use supplements, you want to make sure that those supplements are of the very highest quality. For that reason, we've partnered with Thorne, T-H-O-R-N-E, because Thorne supplements are of the very highest quality and the amounts of ingredients listed on the label of Thorne supplements precisely matches what is actually contained in those capsules, bottles and pills and powders and so forth. This is extremely important. A lot of analysis of supplements and supplement companies have shown that what's listed on the bottle is often not what's actually contained in the bottle. Thorne's stringency is unmatched. They've partnered with all the major sports teams, with the Mayo Clinic. And so, there's a lot of trust in Thorne supplements for all the right reasons. If you'd like to try Thorne supplements, you can see the supplements that I take, you can go to Thorne, thorne.com/u/huberman. There, you can see the supplements that I take. You can get 20% off any of those supplements. And if you navigate into the Thorne site through that

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