

Using Deliberate Cold Exposure for Health and Performance | Huberman Lab Podcast #66

I describe mechanisms by which deliberate cold exposure can enhance mental health, physical health, and performance. I detail specific protocols to safely engage in deliberate cold exposure, including minimal exposure times, time-of-day effects, determining optimal temperatures, recovery, mindset, and movement during cold exposure. I discuss how cold exposure can be used to safely stress the body to improve attention, mood, and cognitive focus and boost metabolism and reduce inflammation. Also, I explain how cold exposure on specific regions of the body (called glabrous skin surfaces) can be leveraged to enhance endurance and weight training and increase work output.

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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, we are going to discuss the use of deliberate cold exposure for health and performance. Temperature is a powerful stimulus on our nervous system and indeed on every organ and system of our body and cold in particular can be leveraged to improve mental health, physical health, and performance, meaning for endurance exercise, for recovering from various forms of exercise, for actually improving strength and power and for enhancing mental capacity. In order to properly leverage deliberate cold exposure for sake of mental health, physical health and performance, you have to understand how cold impacts the brain and body. So today we are going to discuss that. We're going to talk about some of the neural circuits and pathways, some of the hormones involved. I promise to make it all clear and accessible regardless of whether or not you have a scientific background or not. We are also going to discuss very specific protocols that you can apply, which leverage variables like temperature, how cold, how to deliver the cold, for instance, whether or not you use a cold shower, cold immersion, ice bath, circulating water, or still water, whether or not you're going for walks outside in a t-shirt when it's cold or whether or not you're purposefully using things like cryo, if you have access to that or not. One thing I can promise you is that by the end of today's episode, you will know a lot about the biology of thermal regulation, that is how your brain and body regulates its temperature. You will also have a lot of tools in your arsenal that you can use and leverage toward improving mental health, physical health, reducing inflammation in the body, improving athletic performance, improving mental performance. I promise to spell out all those protocols in detail as I go along and to summarize them again at the end. I'd like to make a point now that I'm going to make several additional times during today's episode and that is that temperature is a very potent stimulus for the brain and body. That also means that it carries certain hazards if it's not done correctly. Now, everyone shows up to the table, meaning to protocols, with a different background of health status and there's simply no way that I can know what your health status is. So anytime you are going to take on a new protocol, that means a behavioral protocol or a nutritional protocol or a supplementation protocol, you should absolutely consult a board certified physician before initiating that protocol. I don't just say this to protect us, I also say this to protect you. If you'd like to see our medical disclaimer, you can go to our show notes, it's described there. In fact, I encourage you to please do that. And in general, when

embarking on new protocols in particular, if they involve strong stimuli like changing temperature or placing yourself into unusual temperatures, I would encourage you to progress gradually. I would also encourage you to not look at gradual progression as the kind of weak version of a protocol. In fact, today I'm going to discuss a really beautiful peer reviewed study that involved having people do deliberate cold exposure so they were immersing themselves into water up to about their neck and the water was actually not that cold. It was only about 60 degrees Fahrenheit, which for most people is pretty tolerable. So nowhere near the kinds of extreme temperatures that one could use in other protocols. And the interesting thing is despite that fairly modest cold temperature, by simply extending the duration of time that people were in that water, they experienced enormous increases in neurochemicals that ought to translate to improvements in focus and mood. And indeed, that's what's been observed in subsequent studies. So again, please see our medical disclaimer in our show notes, please proceed with caution always, please also understand that the most potent stimulus isn't always the one that you experience as the most intense in the moment. In fact, I would encourage you to you find the minimum threshold of stimulus that will allow you to drive the maximum benefit from each protocol and indeed, I will point out what those thresholds ought to be today. I'll give you some simple formulas, gauges or guides that you can use in order to navigate this extremely interesting and potent tool

00:04:23 Tool: Moderate Exercise & Cognitive Work

that we call deliberate cold exposure. Before we talk about deliberate cold exposure and its many powerful applications, I'd like to highlight a study that I find particularly interesting, that I think you will find particularly interesting and useful. The title of this study is brief aerobic exercise immediately enhances visual attentional control and perceptual speed, testing the mediated role of feelings of energy. Now, the reason I like this study is first of all, it's a fairly large size sample group. They looked at 101 students. These were college-aged students and they had two groups. One group did 15 minutes of jogging at moderate intensity. So they did measure percent heart rates, et cetera, but this would be analogous to zone two cardio, which I've discussed on this podcast before. Zone two cardio is cardiovascular exercise that places you at a level where you can hold a conversation with a little bit of strain, meaning that you can get the words out, but every once in a while you have to catch your breath whereas if you were to push any

harder by any mechanism going faster or on a steeper incline, et cetera, that you would have a hard time carrying out a conversation. So zone two cardio is a common form of describing that level of intensity that they call moderate intensity. So one group did 15 minutes of jogging at moderate intensity, which I'm translating to roughly zone two cardio. The other group did 15 minutes of relaxation concentration that is somewhat akin to mindfulness meditation. And then they were analyzed for perceptual speed, visual attentional control, something called working memory, which is your ability to keep certain batches of information online. Just imagine someone telling you their phone number, and you have to remember that sequence of numbers in your head for some period of time, that's working memory. And it depends very heavily on the so-called prefrontal cortical networks, which are involved in planning and action. And they also looked at people's feelings of energy and they measured that subjectively, how energetic people felt. Now the major takeaways from this study that I'd like to emphasize are that the 15 minutes of jogging group experienced elevated levels of energy for some period of time after they ceased the exercise whereas the group that did mindfulness meditation actually reported feeling more calm and having less overall energy. Now that's very subjective and indeed they used subjective measures to analyze energy, but what gets interesting is when they looked at performance on these various cognitive tasks and the two tasks that they use were called the trail making tests, they have different versions of this, version A, version B, I don't want to go into too much detail, but version A essentially involves having a page of numbers that are distributed somewhat randomly. So one, two, three, four, five, six, seven, eight and so on, but distributed randomly across the page and people have to use visual search to circle those numbers in sequence. So this involves visual attention, it involves some motor skills, involves a number of things that certainly require energy and focus. The second test was the trail making test part B, as I mentioned earlier, and this involved also circling numbers in sequence, but interspersed between those numbers were letters. So rather than just having to circle off numbers in sequence, they actually had to connect one, then the letter A, then two, then the letter B, et cetera and remember these are randomly distributed across the page. The major takeaway from the study is that the group that did the 15 minutes of moderate exercise prior to these two tests showed significant decreases in the amount of time required to complete these tests accurately. That is interesting and indeed surprising at least to me, because there have been many studies looking at the effects of mindfulness meditation on the ability to focus. The key variable

in the study turned out to be energy. This subjectively measured feeling I should say of having more energy and thereby the ability to focus, especially in these high cognitive demand tasks. Now the takeaway from this study for all of us I think is pretty straightforward. If you are going to sit down to do some work that requires focus and working memory and cognitive attention and especially if it's some visual spatial control, meaning you have to search for things on a page, you have to organize things on a page, so some writing, arithmetic, basically cognitive work of any kind, 15 minutes of moderate exercise done prior to that work about could be very beneficial for you. This does not mean that mindfulness meditation would not be a benefit to you. I wouldn't want you to conclude that, but if you had to choose between doing 15 minutes of mindfulness meditation and doing 15 minutes of moderate exercise prior to a cognitive work about, I would say the 15 minutes of moderate exercise would be more valuable at least based on the data in this paper. In many previous podcasts, I have talked about the powerful effects of doing things like mindfulness meditation, and other forms of NSDR, non-sleep deep rest. So these could be 20 minute naps or just lying there quietly with your eyes closed or yoga nidra or NSDR scripts are available on YouTube and various other places free of cost of any kind. You just go to YouTube, put in NSDR, non-sleep deep rest. Those protocols have been shown to be very beneficial for enhancing neuroplasticity, the changes in the brain and body that encode or shift the neural circuits that allow for memory to change, that allow for learning to occur after a learning about. What I'm referring to today in this particular study is the use of moderate exercise in order to increase one's focus and attention in order to trigger that neuroplasticity. So the simple sequence here is get energetic and alert, do that prior to the learning about, engage in the cognitive work or learning about, and then mindfulness meditation, NSDR and so forth should follow. And if you would like to access this paper and like to look more at the details in the paper, we'll be sure to put a link in the show notes. The first author is Legrand. And again, the title of this paper is brief aerobic exercise immediately enhances visual potential control and perceptual speed, testing the mediating role of feeling of energy. And I also just want to emphasize immediately. I think most people out there are interested in tools and protocols that work the first time

00:10:47 The Brain-Body Contract

and that work every time and indeed, I think this protocol fits that bill. I'm pleased to

announce that I'm hosting two live events this May. The first live event will be hosted in Seattle, Washington on May 17th. The second live event will be hosted in Portland, Oregon on May 18th, both are part of a lecture series entitled the Brain Body Contract during which I will discuss science and science-based tools for mental health, physical health and performance. And I should point out that while some of the material I'll cover will overlap with information covered here on the Huberman Lab Podcast and on various social media posts, most of the information I will cover is going to be distinct from information covered on the podcast or elsewhere. So once again, it's Seattle on May 17th,

00:11:32 AG1 (Athletic Greens), ROKA, Helix Sleep

Portland on May 18th. You can access tickets by going to hubermanlab.com/tour and I hope to see you there. 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 Athletic Greens, also called AG One. I started taking AG One way back in 2012 so I'm delighted that they're sponsoring the podcast. The reason I started taking AG One and the reason I still take AG One once or twice a day is that it covers my foundational vitamin mineral and probiotic needs. It also has adaptogens and things like zinc for immune system function, but the probiotics are one of the key features in there. I've done several podcasts on the gut microbiome, which are these trillions of microbiota that live in our digestive tract, and that are crucial for our immune system, brain function and so on. One way to enhance our gut microbiome to ensure that it's healthy is to make sure that we get the correct probiotics and Athletic Greens has the correct prebiotics and probiotics that ensure a healthy gut microbiome. If you'd like to try Athletic Greens, you can go to athleticgreens.com/huberman to claim a special offer. They'll give you five free travel packs that make it very easy to mix up Athletic Greens while you're on the road. So in the car and on the plane. I should mention the Athletic Greens is delicious. I love the way it tastes. I mix mine with some water and a little bit of lemon or lime juice. The special offer is the five free travel packs plus a year supply of vitamin D three, K two. Vitamin D three has been shown to be important for a tremendous number of biological

functions. Many of us who get sunlight get enough vitamin D three, many of us, even if we do get sunlight, do not get enough vitamin D three. So the year supply of vitamin D three also has K two, which is important for cardiovascular function, for calcium regulation. Again, go to athleticgreens.com/huberman to get the five free travel packs and the year supply of vitamin D three, K two. Today's episode is also brought to us by ROKA. ROKA makes eyeglasses and sunglasses that are the absolute highest quality. The company was founded by two All-American swimmers from Stanford and everything about their eye glasses and sunglasses were designed with performance in mind. Now the glasses were initially designed for athletic performance, meaning they were designed to be worn while cycling or running. And indeed you can wear them while cycling or running. If you get sweaty, they won't slip off your face. They're very lightweight. In fact, you hardly ever remember that they're on your face, at least I can't remember that they're on my face. I wear the sunglasses when I drive, I wear readers at night, but they're not just for athletic performance. They have a terrific aesthetic so you could wear them to the office or to work or to school, they look great. Unlike a lot of high performance sunglasses out there that make people look like cyborgs, these you would be happy to wear anywhere. If you'd like to try ROKA glasses, you can go to roka.com, that's roka.com and enter the code Huberman to save 20% off your first order. Again, that's ROKA, roka.com. Enter the code Huberman at checkout. Today's episode is also brought to us by Helix Sleep. Helix Sleep makes mattresses and pillows that are uniquely designed to your sleep needs. Everybody knows the importance of sleep for mental health, physical health, and performance, but probably what everyone doesn't realize is that you have unique sleep needs, your body and indeed the way you sleep need to be matched the correct mattress in order to get the best possible sleep. Helix understands that and if you go to their website, they have a brief two minute quiz that anyone can take that will match your body type and sleep preferences to the perfect mattress for you. So they ask questions like, do you sleep on your side, your back or your stomach, or maybe you don't know. Do you tend to run hot or cold through the night or maybe you don't know? I matched to the dusk mattress, D-U-S-K, because I wanted a mattress that wasn't too firm nor too soft and I've been sleeping on that mattress for over a year now, it's the best sleep I've ever had. 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 any mattress order and two free pillows. They have a 10 year warranty and you get to try the mattress out for a

hundred nights risk free. They'll even pick it up for you if you don't like it although I think you will like it. I certainly love mine. Again if you're interested,

00:15:37 Circadian Rhythm & Body Temperature

go to helixsleep.com/huberman to get up to \$200 off your mattress order and two free pillows. Let's talk about the use of cold for health and performance. I confess I love this topic because it takes me back to my undergraduate years when I worked in a laboratory studying cold physiology, its effects on the brain and its effects the body. And over the years, I've always kept track of the literature in this area and indeed there have been some tremendous discoveries, both in animal models, so in rodents like mice and rats, but also in humans and today we're going to talk about both categories of studies and I'll be careful to point out when discoveries were made in animal models and when they were made in humans. A key point when thinking about the use of cold as a tool, and the key point is that you have a baseline level of temperature that is varying, changing across the 24 hour cycle. So any use of deliberate cold exposure is going to be super imposed on that rhythm, that circadian rhythm, meaning that 24 hour rhythm. The basic contour of your circadian rhythm in temperature is that approximately two hours before the time you wake up is your so-called temperature minimum. So your temperature minimum is a time within the 24 hour cycle when your body temperature is at its lowest. So if you normally wake up around 6:00 AM, your temperature minimum is probably about 4:00 AM. If you normally wake up at about 7:00 AM, your temperature minimum is probably about 5:00 AM. It's not exactly two hours before your wake up time, it's approximately two hours before your wake up time. Now, as you go from your temperature minimum to the time in which you're going to awake, your temperature is rising slightly. And then at the point where you wake up, your temperature starts to go up more sharply and will continue to go up into the early and sometimes even into the late afternoon. And then sometime in the late afternoon and evening, your temperature will start to decline. And indeed, as you approach sleep, your body temperature will drop by anywhere from one to three degrees. And in fact that decrease in core body temperature is important if not essential for getting into and staying in deep sleep. So temperature rises with waking, that's easy to remember. It tends to continue to rise throughout the day and in the late afternoon and evening, your temperature WILL start to go down and the drop in temperature actually helps you access sleep. That background or what we

call baseline circadian rhythm in core body temperature is important to remember because it helps us frame both the effects of deliberate cold exposure and helps us frame when you might want to use deliberate cold exposure in order to access specific states.

00:18:41 Tool: Quickly Decrease Core Body Temperature, Glabrous Skin

It also points to times within the 24 hour cycle when you might want to avoid using deliberate cold exposure, if your primary goal is to get to sleep. So that's the circadian rhythm in temperature. Now I just briefly want to touch on thermal regulation at the level of body and the brain. And this will be very surprising to many of you. Let's do what's called a Gedanken experiment, which is a thought experiment. Let's say I send you out into the desert heat for a jog or a run and it's very hot outside, 102 or 103 degrees, and you start to move, you start to sweat and of course your core body temperature goes up. Now, then I offer you a cold towel, maybe a really, really cold towel and this towel is saturated with water so you could actually squeeze the water out of that and cool your body off. And our Gedanken experiment is for me to say okay, where are you going to place the towel? How are you going to cool yourself off? And I'm guessing that most of you would think that the best way to cool yourself off would be to drape that towel over your head, maybe your neck, over your torso, that it would feel really, really good, and it would cool you off. Well, that's exactly the wrong approach if you want to cool off. And in fact, if you were to use that approach, your body temperature would continue to increase even more. Yes, even more than had you not placed that cold towel on your head or your torso. And here is why. Thermal regulation meaning your brain and body's ability to regulate your internal core temperature is somewhat like a thermostat and that thermostat resides in your brain. So if you think about the thermostat in your home or apartment, if it's too warm in your home or apartment and you were to take a bag of ice and to put it on that thermostat, what would the thermostat do? It would register the environment as artificially cool. It would think that the environment was actually much colder than it is. And so as a consequence, it would trigger a mechanism to further increase the temperature in the room. And you have such a thermostat as well. It's called the medial preoptic area of the hypothalamus. The hypothalamus is a small region of brain tissue about over the roof of your mouth and a little bit in front of that. So it's basically right behind your nose and over the roof of your mouth and it's a collection of

neurons. Those neurons have a lot of different functions that include things like the control of aggression, the control of sex behavior, the control of temperature regulation and so on. The medial preoptic area has connections with the rest of the brain or areas within the brain, I should say and with many areas within the body, it receives input from receptors in our skin and inside our body that register temperature and it acts as a thermostat. So if the surface of your body is made cool, your medial preoptic area will send signals by way of hormones and by way of chemicals that will serve to heat your body up. So what this means is that if you want to cool down, the last thing you want to do is to bring a cold surface of any kind, towel or splashing water, to the majority of your body surface. It might be very, very surprising to you. And you might say, wait, if I want to cool down, I should jump into a cold lake or something of that sort. That's a different thing altogether. What I'll tell you, and we'll get into this in more depth later, is that if you really want to cool down quickly and efficiently, you should leverage particular portals, meaning particular sites on your body where heat can leave your body more readily and where cooling can have a dramatic and fast impact on your core body temperature, can even save your life if you're going hyperthermic. We're going to talk more about the specific protocols to reduce core body temperature for sake of performance and avoiding hyperthermia later in the episode. Hyperthermia of course is a very, very dangerous situation because while your body can drop in core temperature somewhat and still be safe, you can't really increase your body temperature that much before your brain starts to cook and other organs start to cook and by cook, I mean the cells actually start to die. So you have to be very, very careful with the use of heat. Heat stroke is no joke. People die from heat stroke all the time. You really want to avoid that. One way to avoid that is to cool the appropriate surfaces of your body and the appropriate surfaces in this case are the upper cheeks or I would say the upper half of the face, the palms of your hands and the bottoms of your feet. I've talked about this on the podcast before and in the guest episode with Dr. Craig Heller, my colleague in the biology department at Stanford, but just very briefly, these surfaces, the upper half of the face, the palms of the hands and the bottoms of the feet are what we call glabrous skin surfaces, G-L-A-B-R-O-U-S, glabrous. And those surfaces are unique in that just below them, the vasculature is different than elsewhere in the body. Normally the passage of blood goes from arteries to capillaries to veins, but just beneath the glabrous skin on the bottoms of the feet, the hands in the upper half of the face, you have what are called arterio-venous anastomoses. These are portals of blood that go directly from arteries to veins and in

doing so, allow the body to dump heat more readily, more quickly. So as it turns out that if you are to cool the palms of the hands, the bottoms of the feet and the upper half of the face, you can more efficiently reduce core body temperature for sake of offsetting hyperthermia and for improving athletic performance and maybe even cognitive performance. So we will return to the specific protocols for doing that later in the episode, I'll give you a lot of details about how to do that, how to do that without the use of any fancy or expensive technology. There are some technologies that are now commercially available, for instance, the so-called CoolMitt that will allow you to do that with maximum efficiency, but I'll also give you some at home methods to do this either in the gym or on runs or for sake of cognitive work. So the two key themes again are understand that baseline circadian rhythm in temperature, and understand that the best way to cool the body is going to be by making sure that something cold contacts the bottoms of your feet, the palms of your hands and the upper half of the face. Ideally all three if your goal is to lower core body temperature quickly, and again, just cooling off the back of your neck or the top of your head or your torso with a towel

00:25:26 Mental Effects of Cold Exposure

is going to be the least efficient way to lower core body temperature and might even increase body temperature under certain conditions. With those two points in mind, we can start to think about directed deliberate cold exposure protocols, and there are a number of different reasons to use deliberate cold exposure. And I want to separate those out for you. There are cold protocols that have been tested in peer reviewed studies that are designed to improve mental performance. They are designed to improve things like resilience or your grittiness, or your ability to move through challenge or to regulate your mind and your internal state under conditions of stress and we can define stress very specifically as times when adrenaline also called epinephrine and or norepinephrine also called noradrenaline, are elevated in your body. Forgive me for the noradrenaline, norepinephrine, adrenaline, epinephrine nomenclature, I didn't make that up. It turns out that every once in a while, scientists disagree, imagine that, and you'll get multiple scientists naming the same molecule different things. So epinephrine and adrenaline are the same thing. I will use them interchangeably. Norepinephrine and noradrenaline are the same thing. I will use those terms interchangeably. Noradrenaline and adrenaline are often co-released in the brain and body. So they work as kind of a

pair to increase our level of agitation, our level of focus and our desire and our ability to move. They are often co-released from different sites in the brain and body with dopamine, a molecule that is commonly misunderstood as the molecule of pleasure, but is actually the molecule of motivation, reward and pursuit. So dopamine, norepinephrine and noradrenaline tend to be released together under certain conditions and today you'll learn how deliberate cold exposure can be used to cause increases in the release of several, if not, all of these in ways that can improve your levels of attention and your mood. But the key point is that your mental state is shifted when you are exposed to certain forms of cold, and many people use deliberate cold exposure specifically to shift their body state as a way to train their mental state so that they can better cope with stress in real life and by real life, I mean when life presents stressful events, and I will give you specific protocols as to how you can do that, in other words, how you can become more resilient through the use of deliberate cold exposure. Now, because of the ways in which deliberate cold exposure can increase this category of chemicals called the catecholamines, that includes dopamine, norepinephrine and epinephrine, it can also be used to elevate mood for long periods of time. And I'm going to discuss a specific protocol that has been shown to increase these chemicals anywhere from 2.5X to 250%, to as high as 500%, five times over baseline. Now you might be asking whether or not it is a good thing to raise chemicals like norepinephrine and dopamine to such a great degree, whether or not that's healthy for us, whether or not they can harm us. But it turns out that these elevations in norepinephrine and dopamine are very long lasting in ways that people report feeling vast improvements in mood and vast improvements in levels of cognitive attention and energy. So by my read of the literature, these seem to be healthy increases in our baseline levels of these chemicals in ways that can really support us

00:29:02 Physical Effects of Cold Exposure

so I'll give you a protocol for that. Now, those are some of the mental effects of deliberate cold exposure, but deliberate cold exposure has also been studied in animal models and in humans in the context of increasing metabolism, even in converting certain fat cells that we call white fat cells, which are the ones where energy is stored, they're the ones that we typically think of as kind of blubbery fat, to beige or brown fat, which is thermogenic fat, meaning that it can increase core body temperature and serves kind of the furnace by which we increase our core metabolism. So with a very

broad stroke, I can say that white fat is generally the kind of fat that people want less of and beige fat and brown fat is generally the kind of fat that if you're going to have fat cells and you certainly need fat cells that you want more of. They are thermogenic, they help you stay lean. They actually serve as a reservoir for heating your body up if you're ever confronted with a cold challenge. So we're going to talk about how to use cold for metabolism as well. And of course, people are using deliberate cold exposure to reduce inflammation post exercise, to reduce inflammation generally. And people are also using cold to enhance performance

00:30:11 How Cold Should the Temperature Be?

in the context of strength training, in the context of endurance training and we'll talk about those data as well, but where I'd like to start is with mental performance and I'd like to detail what happens when we deliberately expose ourselves to cold. It's key to point out the word deliberate. If I don't say otherwise, then throughout this episode, if I say cold exposure, I mean deliberate cold exposure. And the reason I point that out is that as my colleague, David Spiegel, and the department of psychiatry at Stanford says, it's not just about the state that we are in, it's about the state that we are in and whether or not we had anything to do with placing ourselves into that state and whether or not we did that on purpose or not. And what he really means by that statement is that there are important effects of what we call mindset. Mindset was a topic discussed in the guest episode with Ali Crumb some weeks ago. If you haven't seen that episode, I highly recommend it. And the science of my mindset tells us that if we are doing something deliberately and we believe that it's going to be good for us, it actually can lead to a different set of physiological effects than if something is happening to us against our will or without our control. Now, this is different than placebo effects. Placebo effects are distinct from mindset effects. If you want to learn more about that distinction, please see the episode with Ali Crumb. But again, when I talk about cold exposure in this episode, I'm talking about deliberate cold exposure, meaning that you are placing yourself into a cold environment on purpose in order to extract a particular set of benefits. When we talk about deliberate cold exposure, almost always, that means getting uncomfortable. And one of the most common questions I get when discussing the use of cold for sake of mental or physical performance, metabolism, et cetera, is how cold should it be? How cold should the water be? How cold should the environment be? And I just will tell you

now and I'm going to say this again and again throughout the episode, cause it will continue to be true throughout the episode and long after the episode is over, how cold depends on your cold tolerance, your core metabolism, and a number of other features that there is simply no way I could know or have access to. So I would like you to use this rule of thumb. If you are using deliberate cold exposure, the environment that you place yourself into should place your mind into a state of whoa, I would really like to get out of this environment, but I can stay in safely. Now that might seem a little bit arbitrary, but let's say you were to get into a warm shower and it would feel really, really nice and you were to start turning down the warm and turning up the cold. There would be some threshold at which it would feel uncomfortable to you. And if you were to continue to make a little bit colder than that, you would really want to get out of the shower, but you are confident that you could stay in without risking your health, without risking a heart attack. Now that's very different than jumping into a very, very cold lake or I've seen these images of people that will cut holes into frozen over lakes and they'll get into that cold water. If you are trained to do that and you have the right conditions, et cetera, that can be done reasonably safely, but that's certainly not what I would start with. And for many people, that would be too cold and indeed some people can go into cold shock and can die as a consequence of getting to that extremely cold water very quickly. Now that's not to scare you away from deliberate cold exposure. It's just to say that there's no simple prescriptive of how cold to make environment in order to extract maximum benefit for mental or physical performance. So the simple rule of thumb is going to be place yourself into an environment that is uncomfortably cold, but that you can stay in safely. And you'll have to experiment a bit and that number, meaning that temperature, will vary from day to day. It will vary across the 24 hour cycle because of that endogenous, meaning that internal rhythm, in temperature that I talked about earlier. Low early in the day, rises into the afternoon, drops at night. You can actually do this experiment if you like. Try getting into a cold shower at 11 o'clock at night if you want versus try doing it in the middle of the afternoon. It's quite a different experience and by quite a different experience, I mean it requires quite a different degree of resilience and leaning into the practice. Your willpower will have to be higher I suspect late in the day as it compared to early in the day, but that will vary of course between individuals as well. So the most common question I get about deliberate cold exposure is how cold should the water be? And we've answered that with uncomfortably cold to the point

00:34:53 Cold Showers vs. Cold Water Immersion

where you want to get out, but you can safely stay in. The second most common question I get about deliberate cold exposure is whether or not cold showers are as good, better or worse than cold water immersion up to the neck, for instance. I also get a lot of questions about whether or not cryo chambers are better than all the others, et cetera, et cetera. I'm going to make all of that very simple for you by saying cold water immersion up to the neck with your feet and hands submerged also is going to be the most effective. Second best would be cold shower. Third best would be to go outside with a minimum amount of clothing, but of course, clothing that is culturally appropriate and that would allow you to experience cold to the point where you would almost want to shiver or start shivering. Now there are a number of different, important constraints that are going to dictate whether or not you use one form of cold exposure or the other. For instance, some people don't have access to cold water immersion. They don't have access to ice baths or cold water tanks, cold ocean or cold lakes, et cetera. In that case, showers would be the next best solution. I do want to emphasize that there have been very few, if any, studies of cold showers, and you can imagine why this would be the case. In a laboratory, you want to control for as many variables as possible. So placing people into a cold water immersion or an ice bath up to the neck and insisting they keep their hands and feet under is very easy to control. It means that everyone can do essentially the same thing whereas with cold showers, people are different sized bodies. Some people are going to put their head under. Some people are going to lean forward. Measuring the amount of cold water exposure on the body is very hard to do and so there aren't a lot of studies of cold showers, but of course, a lot of people don't have access to cold water immersion so they have to use cold showers. And if you don't have access to both, of course, then going outside on a cold day can be of a benefit. But I will point out that the heat transfer from your body into water is much higher, four times greater, if not even greater, depending on the temperature of the water, in water as opposed to in air. So it's going to be much more efficient to do cold water immersion than anything else, cold showers after that and put yourself into a cold environment would be the third best thing. I'm not going to get into cryo chambers because they carry quite a high degree of cost. And again, there aren't many studies of them. So if you have access to cryo chambers, I'm sure that the cryo chamber facility has told you about all these incredible benefits and I don't doubt that some of those benefits truly exist, but

most people just don't have the resources or the access to those so we're going to leave cryo chambers out of today's discussion. And of course I realize there's a fourth category of cold exposure out there. People are wearing ice vests. Believe it or not, those exist, ice underwear. Yes, those exist. You can look for them on Amazon if you like. They are putting cold packs in their armpits or in their groin or elsewhere in order to stimulate some of the effects of cold on mental and physical performance. I'm not going to address those in too much detail today. They can be efficient in certain ways, but as you'll learn about later in the episode, cooling the palms, the upper face and the bottoms of the feet is going to be far more efficient and unfortunately I think most of the people that are using ice packs to increase their core metabolism are not aware of the glabrous skin cooling and how it can be a very, very potent stimulus so we'll return to that later.

00:38:27 Protocols for Cold Exposure

Unless I say otherwise, I'm mainly going to be focusing on cold water immersion and cold showers. So let's talk about protocols for enhancing mental health and performance using deliberate cold exposure. What happens when we get into cold is that we experience an increase in norepinephrine, in noradrenaline release and in adrenaline release. The fact that cold exposure, deliberate or no, increases norepinephrine and epinephrine in our brain and body means that it is a very reliable stimulus for increasing norepinephrine and epinephrine. That's sort of an obvious statement, but that obvious statement can be leveraged to systematically build up what we call resilience. Now, when we experience a stressor in life, whether or not it's something bad happens in our relationship or something bad happens in the world and we feel stress, that stress is the consequence of increases in norepinephrine and epinephrine in our brain and body. Very similar, if not identical, to the kinds of increases that come from deliberate cold exposure. So deliberate cold exposure is an opportunity to deliberately stress our body and yet, because it's deliberate and because we can take certain steps, which I'll describe in a moment, we can learn to maintain mental clarity, we can learn to maintain calm while our body is in a state of stress. And that can be immensely useful when encountering stressors in other parts of life. And that's what we call resilience or grit, our ability or mental toughness, our ability to lean into challenge or to tolerate challenge while keeping our heads straight, so to speak. So one simple protocol for increasing resilience is to pick a temperature that's uncomfortable of shower or cold immersion, and

then to get in for a certain duration of time and then to get out. Now, it's important to understand that people will experience different levels of norepinephrine and adrenaline release when getting into cold water. Some people, because they dread the cold so much, will actually experience norepinephrine and epinephrine increases even before they get into the cold water or under the cold shower. Now you may have experienced this. I've certainly experienced this. I'm dreading it, I don't want to do it and I have to force myself to do it. And indeed epinephrine and norepinephrine and its surges can be thought of as sort of walls that we have to confront and go over. And I'd like you to conceptualize them that way, because it allows us to build protocols that can be very objective and can allow us to monitor our progress in terms of building resilience. So one option is to simply say, okay, I'm going to force myself to get into the cold shower for one minute. How cold, again, uncomfortably cold, but you can stay in safely or I'm going to get into the ice bath for one minute. Ice baths are very cold inevitably. And what is also inevitable is that when you get into the cold, you will experience a surge in epinephrine and norepinephrine. That's non-negotiable because it's mediated by cold receptors on the surface of your body and your skin and the way that they trigger the release of norepinephrine and epinephrine, not just from the adrenals, from the adrenal glands above your kidneys, but also from regions of your brain, like the locus coeruleus, which cause increases in the tension and alertness, and from other locations in your body where epinephrine and norepinephrine are released. In other words, cold is a non-negotiable stimulus for increasing epinephrine and norepinephrine. Even if you are the toughest person in the world and you love the cold, that increase in epinephrine and norepinephrine is going to happen. So the way to think about norepinephrine and epinephrine in this context of building mental resilience is that you have two options. You can either try to extend the duration of time that you are in the deliberate cold exposure. So going from one minute to 75 seconds to two minutes and so on over a period of days or one way to approach this and the way that I particularly favor is to take the context of the day and the moment into account, meaning we have different levels of grit and resilience on different days and depending on the landscape of our life at the time, even the time of day that we're doing these protocols and start to be able to sense the release of epinephrine, and norepinephrine in our brain and body and see those as walls that we want to climb over in order to build resilience and to start counting the number of walls that we traverse and the distance between those walls as we do deliberate cold exposure. Let me give you an example of the timed protocol because that one is very

straightforward, although I do not think it is as powerful for building mental resilience. The time protocol would be Monday, I do one minute of deliberate cold exposure at a given temperature. Wednesday, I extend that by 50% and Friday, I do deliberate cold exposure for twice as long as I did it on Monday. And if I were to continue that every week, Monday, Wednesday, Friday, I would continue to either increase the duration or I would lower the temperature and reduce the duration, this kind of thing, very much like sets and reps in the gym. Now that option is very objective. You could even log it in a book and as you develop the ability to stay in cold temperatures, even progressively colder and colder temperatures for longer and longer periods of time, you will become more resilient. What do I mean by that? Well, my operational definition of resilience is that you are able to resist escape from the stressor, the cold, by virtue of your willpower, which is really your prefrontal cortex causing top down control on your reflexes and your limbic system and your hypothalamus, which are basically telling you to get out of that cold water, get out of that cold environment and in doing so, you are basically getting better at controlling your behavior when your brain and body are flooded with norepinephrine and epinephrine. That's a very reductionist way to explain resilience or grit or mental toughness, but it's a reductionist way of explaining it that is very closely tied to the biology end of the psychology. And it is a fact that norepinephrine and epinephrine release in the brain and body are the generic universal code for stressor. There is no unique chemical signature for different forms of stressors, that is the only one, although of course there are other chemicals involved as well. So you could go for time and you could try and reduce the temperature and increase the time over a period of days or weeks. Now that's an attractive way to approach things, but the problem is that you don't have an infinite amount of room with which to lower temperature, because eventually you will get into temperatures that are either so cold that they are dangerous or you have to stay in cold temperatures for such long periods that it becomes impractical because presumably you also have to take care of other aspects of your life, you can't just sit all day in the ice bath. Now for that reason, I favor a protocol in which you build mental resilience and mental toughness through two different types of protocols. The first one involves counting walls. Now, what do I mean by walls? I mean the sensation of, no, I don't want to do this and the idea or the sensation in your brain and body that you actually want to leave that environment and go warm up. Now again, for some people, that will be even before getting into the ice bath or cold shower. So if you are feeling very resistant to getting into the ice bath or cold shower and you manage

to do that, that's going over what I would call one wall. Then for some period of time, you might actually feel comfortable in the ice bath, cold water or cold shower. And you feel like you could stay there for some period of time, that you could stay there for a minute or two minutes, but inevitably, the next wall will arrive. And I would encourage you to pay attention to when that next wall arrives and actually having an awareness, that so-called interceptive awareness as we call it, of when that next surge adrenaline epinephrine comes or whether or not it reaches a certain threshold in your brain and body that you feel you want to get out and you're able to stay in for even just 10 seconds longer, that means you've traversed yet another wall. And if you continue to stay in that cold environment, you'll find that the next wall will come and the next wall will come. Now eventually of course, you will get very, very numb depending on how cold it is and you could also place yourself into danger. So you have to maintain cognitive control, counting these walls, traversing these walls, but getting out at some point, of course. So my favorite protocol for building mental toughness AKA grit, AKA resilience, is to take into account that some days, just getting into the ice bath or cold shower represents a wall, some days it doesn't. Some days you get in and you feel you could go 10 minutes, other days you get in and you feel like you could only go a minute and setting a designated number of walls before you start the protocol is going to be very beneficial here. So you say, as long as I can do it safely, I'm going to do three walls today. The first wall is getting in. The second wall will arrive when it arrives and the third wall will arrive when it arrives and I'll get over that wall and then I'll get out. The next day, you might do five walls. The next day, you might do three walls again, but you might lower the temperature. This gives you tremendous flexibility and indeed it gives you much more latitude to be able to use the same temperatures in different ways, or to reduce the temperature only a little bit and still get a lot of stimulus, meaning a lot of results out of a given protocol. Whereas people who are just going for temperature and time eventually become cold adapted. They get very, very good at doing three minutes or six minutes or even 10 minutes at a given temperature and so then they feel like they have to lower the temperature even more and even more and eventually they just bought them out. There's nowhere else to go. There's no way to get improvements out of the protocol. At least not in terms of mental resilience. Of course, there's still the positive effects on inflammation and metabolism, et cetera, that we'll talk about in a little bit. But the key thing here is to design protocols that are going to work for you over time and for you very, very hardy, very, very tough guys and gals out there that can get right into an ice

bath or a very, very cold immersion and you can just grind it out for six or 10 minutes, or you can even do that by remaining peaceful, well more points to you, but guess what? That's the equivalent of already having loaded up the barbell with 600 pounds and done your 10 reps. There's not a whole lot more variable space with which to get benefits from that stimulus. And in the weight room, people understand that you can adjust, for instance, the speed of the movement, or you can start combining that movement with pre-exhaustion, et cetera. With cold exposure, you don't have as much variable space to play with. So if your goal is to build resilience, either go for time as a function of temperature, or what I suggest is to start recognizing these walls as an experience of resistance in you and going over those walls, set a certain number of walls that you're going to go over on a given day and do that at a given temperature, and then to mix it up. And ideally you might even throw in one more wall at the end, if you're really feeling bold and brave because that's going to build out further resilience. But if you want cold exposure to work for you for sake of building up resilience and mental toughness over time, you're going to want to vary this parameter space in some sort of way. And you don't have to be super systematic about it. That's the beauty of this kind of approach because you're relying on the fact that those walls really represent times in which you are forcing your top down control, your prefrontal cortex to clamp down on your reflex and you're learning behavioral control in the context of your body having elevated levels of these catecholamines, norepinephrine and epinephrine. And that translates to real life in a much more realistic way I believe because in real life, you're not really engaging in stressors for a given amount of time that you know how long it's going to last and you know the context, no. Most stressors arrive in the form of surprises we don't like, text messages that deliver bad news, information about the outside world or real world and online interactions that send our system into a state of increased norepinephrine and epinephrine. And if you start to think of those as walls that you can tolerate and climb over while staying and calm and clear of mind, then you can really imagine how the ice bath

00:50:57 Optimal Mindset(s) During Cold Exposure

and other forms of cold exposure are really serving to train you up for real life stressors. The next question that I always get is what should my mental state be while I'm exposing myself to this uncomfortable, yet safe condition of cold? Well, you have two options and

there are probably other options as well. One is to try and calm yourself to remain as mentally still as possible. The other is to lean into that challenge and so to grind it out and here, I have to say that this is a lot like teaching someone to drive on a gravel road. For any of you that have driven on a gravel road, you know that there is no optimal speed for all gravel roads. It depends on the density of the gravel, et cetera, and the vehicle, et cetera. So for instance, on some gravel roads, when you start to drive and the dust starts to kick up, your best option is to drive fast and put that dust cloud behind you. On other gravel roads, if you try and do that, the dust actually kicks up around the vehicle and it makes it hard to see and sometimes you have to slow down. The same thing is true for getting through deliberate cold exposure. Sometimes it's easier to calm yourself. One way to do that is through double inhales through the nose and extended exhales through the mouth, or simply by trying to control your breathing and reduce the pace of your breath and increase the volume of your breathing. I have to say that everyone experiences a shortening of breath when they get into uncomfortably cold water, that is a universal physiological response. Everyone also experiences a 30 to 80% decrease in cognitive function, in particular, the frontal cortex. The metabolism of your frontal cortex goes down, the metabolism meaning the activity of brain areas associated with stress and panic goes way up. And so anchoring your mind in cognitive activities as you get into the cold can be very, very helpful for maintaining clarity of mind. In fact, one thing that I sometimes recommend is that people try and engage in some sort of cognitive exercise while in the cold, not as a form of distraction, but as a way to maintain clarity of thinking and to learn how to do that when the body is flooded with all these chemicals that make us stressed. So for instance, you could do math problems and not two plus two equals four, not three times three equals nine, but things that require a little bit more focus and attention working memory and so forth. You could also start to have thoughts that you deliberately impose a full sentence structure on. That's actually quite tough. You could try and recall specific bouts of information that are challenging. This is teaching your mind how to stay online, or rather I should say, this is you teaching your prefrontal cortex, how to stay engaged while you have high levels of stress in your body. Years ago, I had a friend who works in the neuroscience world, research neuroscientist, who was obsessed with this very bizarre sport that I don't necessarily recommend at all, which is the combination of boxing and chess. You may have seen this on YouTube where people will box around, legitimate boxing around, they're sparring all out often. And then at the end of the round, instead of resting in the

corner, they actually sit down and play chess, and then they go back to boxing and back to chess. Again, not a sport that I recommend, but the reason he was obsessed with this is because he studies the impact of stress on cognitive performance. And what that particular very bizarre sport was doing was toggling back and forth between different states of mind. Now it's used both to increase cognitive clarity for the fighter when they box, because staying calm and clear thinking is very important to winning boxing matches. Believe it or not, it's not an all outrage. It's a very calculated game of mental chess and physical chess that's quite high stakes as you can imagine. It's also used in some circles as a way to teach people how to engage in cognitive performance when their body is simply filled to a stress. So in the boxing chess example, the replacement for the cold water is actually the boxing, it's the thing that's supposed to induce the stress cause getting hit is stressful and the risk of getting hit is stressful for most people. So again, if you think about deliberate cold exposure as a way of just systematically and reliably inducing epinephrine and norepinephrine release and delivering stress, well then this idea of maintaining cognitive clarity and actually engaging in cognitive tasks while in the ice bath or cold shower can actually be very beneficial. Even though it might sound a little bit silly, you are really training up your ability to keep your brain working

00:55:26 Tool: Using Movement During Cold Exposure

when the reflex is to shut down the parts of your brain that are involved in deliberate planning and thinking. Now another important aspect of deliberate cold exposure that I rarely if ever hear discussed, but is vitally important is whether or not you move around or not. And here's the reason. When you get into cold water and you remain there for some period of time, your body is generating heat and that heat generates what's called a thermal layer that surrounds your entire body. So if you stay still, you are actually warmer than if you move around, you can try this the next time you're doing your deliberate cold exposure. If you're submerged up to the neck, sit there for about 10, 30 seconds and be very, very still of body. In fact, this is the way that most people start to do deliberate cold exposure. They give this very stoic look. They don't blink, they look very peaceful. Some of them even look tough or they make a very even A, emotional face and so it looks like they're really tough, but they are so still that believe it or not, they're not providing the most potent stimulus. If they or you were to move around in that water, what would happen is you'd break up the thermal layer and that you actually

experience that as much colder. So if you really want to push the resilience aspect, or for instance, if you want to use a given temperature that you're comfortable in, but that you want to increase the stimulus and you want to get some more benefit for mental resilience training, well then get into the cold water, move your body around continuously, but try and keep your mind still, or even do some sort of cognitive task. So as you're starting to realize, there are a bunch of different variables that you can play with while maintaining the same temperature of water and in doing so, really keep you in the zone of what should and absolutely has to be safe for you without having to just continually drop the temperature from say 60 degrees to 55 to 40 to 33 because as I mentioned before, eventually you're going to bottom out. So if you're one of those people that likes to look tough or really relaxed while you're in the ice bath or cold water immersion, just realize that you're actually cheating yourself out of part of the stimulus. Keep those limbs moving and of course, limbs under the water, feet and hands is going to be a more potent stimulus than hands and feet out for reasons that should be obvious based on what we talked about in terms of glabrous skin cooling. Keep those submerged, move your body,

00:57:51 Optimal Frequency of Cold Exposure

maybe move your knees up and down, pedal your feet and trust me, it's going to feel a lot colder than were you to remain stone still. Another very common question is how often to do deliberate cold exposure. It's tough to make a recommendation on that based on any peer reviewed study although there are a few in humans that point to a threshold of 11 minutes total per week. So that's total throughout the week divided into two or four sessions of two or three minutes or so. Now that 11 minute cutoff is not a strict threshold and is actually geared more towards increases in metabolism, we'll get into this a little bit later in the episode, but I think the 11 minute threshold, meaning 11 minutes total of deliberate cold exposure per week is a pretty good number to use if you need a number in order to keep you consistent. But as we talked about earlier, some of you are going to be in the ice bath or cold immersion or cold shower for one minute, others of you will be in there for 10 minutes, depending on how frequent and how high, if you will, those walls of adrenaline are coming. So for some of you, getting into a cold shower for three minutes total for the whole week will represent a tremendous achievement in terms of willpower and overcoming the resistance to doing that, overcoming those walls. For

others of you, three minutes is nothing. So what do I recommend, I recommend that you get at least 11 minutes total per week, but at the point where 11 minutes total per week is very easy for you, where is no longer representing a significant mental challenge, meaning you're not experiencing many of these walls, you're excited to get into the cold shower immersion, you're going through it easily, you're cruising basically. Then I would say either lower the temperature safely, of course, extend the duration safely, of course, or increase the frequency so that you're doing this perhaps every day or maybe five days a week or three days a week. I personally get tremendous benefit from doing deliberate cold exposure three times a week and using the walls method that I described earlier as my gauge for how long to stay in and typically that means that I'm staying in for anywhere from two minutes to six minutes per session and that averages out to about 11 to 15 minutes total per week. So again, I do not think that you need to be super strict about these guidelines. It's most important when embracing a protocol A, that you do it safely, but secondarily that you do it consistently. So find what you can do consistently and then vary the parameters that will allow you to continue to do deliberate cold exposure consistently,

01:00:22 Cold Exposure for Dopamine, Mood & Focus

regardless of whether or not you have access to a shower or cold immersion, et cetera. So we've been talking about mental effects and the use of deliberate cold exposure for sake of building resilience, which I do believe can be tremendously powerful. Look, it's no coincidence that the screening and the training for Navy Seals involves a lot of exposure to cold water. One could argue that it is deliberate because they elect to go to buds, but when they get into the cold water at buds is dictated by the instructors and the reason they use cold water exposure as the stressor is that it does offer considerable leeway in terms of duration and temperature, in terms of how you can use it as a stressor whereas things like heat don't offer much variable space as we say. There isn't a lot of room beyond which you start injuring or even killing people by using heat. So there are a lot of forms of stressors out there, but cold is one that we can titrate, that we can adjust in ways that can allow us to continually build up and or maintain mental toughness. Now, deliberate cold exposure also has many effects on chemicals other than norepinephrine and epinephrine, most notably the neuromodulator dopamine, which is involved in elevating our mood, making us feel energized and enhancing our

ability to focus. And that has a lot to do with how dopamine engages us in motivated states, tends to narrow our thinking in our behavior into a particular trench of goal-directed behavior. If you want to learn more about dopamine, you can learn a lot about dopamine in our episode about dopamine, it's at hubermanlab.com. You can find it, it's a two and a half hour plus kind of deep dive into all things dopamine, focus, motivation, et cetera. Deliberate cold exposure has a very powerful effect on the release of dopamine in our brain and body. And this is one of the main reasons why people continue to do deliberate cold exposure. Basically it makes us feel good and it continues to make us feel good even after we get out of the cold environment. In fact, some people would say they don't feel good in the cold environment, it's all stress for them, but afterwards they feel great. One of our previous guests, Dr. Anna Lembke, who's a medical doctor at Stanford University School of Medicine, she's a close colleague of mine, described the use dopamine in her book, *Dopamine Nation*, an incredible book about addiction and dopamine I should mention. And the use of dopamine elicited by cold water exposure by one of her patients. What I'm referring to is the fact that one of her patients helped themselves get and stay sober off drugs by using deliberate cold exposure to increase dopamine. So a healthier form of dopamine release than they were engaged in prior to getting sober. Now, the basis for dopamine release in response to cold exposure is that the catecholamines, norepinephrine, epinephrine and dopamine tend to be co-released by the same sorts of stimuli, but most stressors and in particular things that evoke stress or our feelings of stress internally that we don't like do not increase dopamine. They only increase norepinephrine and epinephrine, but deliberate cold exposure seems to cause a dramatic increase in dopamine. And this has actually been substantiated in a really beautiful study entitled human physiological responses to immersion into water of different temperatures. The first author is Sramek. I'm almost certainly pronouncing that poorly and if not incorrectly, S-R-A-M-E-K. This was published in the *European Journal of Applied Physiology* in the year 2000, really a beautiful study, I love this study. They took people and they had them sit in chairs underwater but their head was out and so they were immersed up to the neck in either of three different temperatures. 32 degrees Celsius, which is 89 degrees Fahrenheit, 20 degrees Celsius, which is 68 degrees Fahrenheit, or 14 degrees Celsius, which is 57.2 degrees Fahrenheit. So not super cold, but then what they did is they measured people's core body temperature throughout. They measured their metabolism and they looked at serum levels of things like norepinephrine, epinephrine, dopamine, and cortisol, serum meaning within the blood.

So a really nice and quite thorough study. There were not a huge number of subjects in the study, but nonetheless, it was a very thorough study in terms of the number of variables that they explored. So I just want to briefly highlight some of what they saw or what they observed in this study. First of all, all the groups were in the water of a given temperature for one hour, which is much longer than most of the deliberate cold exposure protocols that anyone is using at home. I mean, maybe you're taking one hour long cold showers, maybe you're getting into the ice bath for an hour although I don't recommend that. I think you'd probably get badly hypothermic or maybe you're getting into a cold water immersion for some period of time, but I have a hard time imagining that it would be an hour and I don't suggest that if it's very cold. So this study focused on actually somewhat moderately cool temperatures, not what I think most people would consider very, very cold temperatures, but extended the duration for quite a while. So again, 32 degree Celsius, 20 degree Celsius or 14 degree Celsius. Here's what they observed. The group that was immersed up to the neck in 32 degrees Celsius, that is 89 degrees Fahrenheit, water did not experience a shift in metabolism nor a significant increase in dopamine, norepinephrine or these other catecholamines. The group that was in 20 degree Celsius, meaning 68 degree Fahrenheit, water for an hour experienced a 93% increase in metabolic rate, which is remarkable given that the water wasn't that cold and yet an hour is a pretty long time to be in there. And again, it speaks to the dramatic effect of heat transfer that water has, which I mentioned earlier, as opposed to being out in the air at 68 degrees, it would certainly not cause that increase in metabolic rate. The group that was at 14 degrees Celsius, meaning 57.2 degrees Fahrenheit, water for an hour experienced a 350% increase in metabolism. So huge increases in metabolism. Now the most interesting data to me, at least in terms of mental effects of deliberate cold exposure, were that the plasma or serum levels of norepinephrine in the blood increased 530%. These are huge increases in norepinephrine so it suggests that this is a stressful stimulus at least neurochemically speaking, stressful, despite the fact that it's not super super cold, although 57.2 degrees Fahrenheit, 14 degrees Celsius it's not a warm environment, but it's not a ultra, ultra cold environment, but an hour is a very long time to be in there. The subjects also experienced a 250% increase in dopamine concentrations, which while not 530% as it was with norepinephrine is still a very large increase in baseline levels of dopamine. And what was interesting is that those increases in dopamine persisted for a very long period of time afterwards, even out to two hours. And they stopped the study after 120 minutes of getting out of the cold, but

nonetheless, these increases in norepinephrine are huge and long lasting and these increases in dopamine are very large and long lasting. And I do believe that these documented effects in humans explain much of the enhancement of attention and of feelings of wellbeing and mood that people typically experience after doing deliberate cold exposure. And the reason I say that is that if you were to go back to the episode that I did on dopamine, or you were to go back to the episode that I did with Dr. Anna Lembke on addiction and dopamine, what you would find is that increases in dopamine of the sort evoked by deliberate cold exposure are actually very similar to the kinds of increases in dopamine that are elicited by things like nicotine or from other behaviors that are known to be addictive and bad for us because they lead to other effects on the brain and body that we simply don't want. And yet deliberate cold exposure provided is done safely can create similar if not greater increases in dopamine that are not just fleeting, that don't just occur during, say the consumption of some deleterious drug or activity, but that are very long lasting and that can be leveraged toward activities other than deliberate cold exposure. So I want to emphasize this. I'm not suggesting that people do deliberate cold exposure for an hour a day. And unfortunately there are not many studies yet exploring how shorter colder temperature environment exposure, say one minute or three minutes or six minutes at 55 degrees or at 50 degrees, whether or not that leads to similar, greater or reduced levels of dopamine in the brain and body. And yet almost everybody who does deliberate cold exposure will say yeah, it was stressful. I didn't enjoy it, or I eventually grew to like it, but that I always feel better afterwards and then that feeling last a very long period of time. And I think it's almost certain that those experiences that people report relate to these increases in dopamine and in concert with the increases in norepinephrine also explain the other effect that's commonly reported, which is an enhancement in mental acuity and the ability to focus. Now, here we can extrapolate to the study that I discussed at the early part of the episode, where I was talking about the use of short 15 minute exercise, kind of moderate intensity exercise and how that was shown to increase levels of energy and mental acuity in these working memory, visual attention tasks. And there, again, we have to assume somewhat because they weren't doing neurochemical measurements, but we can reasonably assume that those improvements in cognitive performance were due at least in part to the increase in catecholamines known to a company, moderate intensity zone two cardio. So what you're starting to see here is a theme. The theme is that virtually any stimulus that delivers more norepinephrine, epinephrine and dopamine to

our system will sharpen our mental acuity and elevate our mood and will do so for some period of time. Deliberate cold exposure, it turns out, is a very potent way to increase these catecholamines, this category of chemicals and thereby to improve mood, mental acuity and levels of alertness. And as we'll next see, it not only has that effect, which can be very beneficial for many people in a bunch of different circumstances, but it also has the positive effects that many people seek in terms of metabolism, in lowering inflammation in the body and other physiological effects as well. And forgive me, I was almost ready to move on to effects of deliberate cold exposure on metabolism and inflammation and so forth, but I neglected to point out one of the other very interesting aspects of the study showing deliberate cold exposure can increase in norepinephrine and dopamine, which is that they observed no significant increases in the stress hormone cortisol and that is both surprising, interesting, and important because what it means is that the quality of stress that deliberate cold exposure is creating in the body is likely to be one of what we call use stress. Hans Selye, the great physiologist, won a Nobel Prize for distinguishing between distress, which is stress in the brain and body that causes the release of things like cortisol along with the other catecholamines, and that we experience as negative happening to us and can lead to negative health outcomes. And he distinguished that from eustress, which was stress that we now understand is associated with increases in things like norepinephrine and dopamine, but no increases or minimal increases in cortisol, and that can lead to positive health outcomes. So it appears that deliberate cold exposure can create what we call or what Hans Selye called eustress. In other words, it can create a condition in the brain and body in which we are stressing ourselves,

01:12:55 Cold Exposure & Metabolism, Brown Fat

we are training up resilience, and yet we are creating a neurochemical milieu that actually has many health benefits. Now I'd like to shift our attention to the effects of deliberate cold exposure on metabolism. And I'd like to start by detailing a study that was performed on humans and published just at the end of last year. The title of the study is altered brown fat thermoregulation, and enhanced cold induced thermogenesis in young, healthy winter swimming men. And I should point out that while the study was only performed on male subjects, there's no reason to think that the effects that they discovered would only pertain to men. I would hope that they would also do a study on

women at some point in the future, but the effects that they describe are very basic core physiological processes. What they did is they looked at deliberate cold exposure in this group of young men, and they used that 11 minute threshold per week. So in other words, they had them get into cold water for approximately 11 minutes per week. And again, that's 11 minutes total per week. They divided that into two sessions although in speaking with the first author of this study, Dr. Susanna Sørberg, I learned that it probably is not important that it be two sessions, it could be three or even four sessions, as long as it reaches that 11 minute threshold. What they discovered was that by going into these cold environments, in this case cold water immersion up to the neck, for 11 minutes total per week, that these men experienced increases in so-called brown fat thermogenesis, I'll talk more about what that is in a moment, and increases in core body temperature that translate to increases in core body metabolism. Now, the overall increases in core body metabolism that they experienced were not extremely large. They were statistically significant, but they weren't extremely large. However, the changes in brown fat stores are perhaps what's most interesting about this study and I'll tell you why. The metabolic increases of deliberate cold exposure are both acute meaning happening in the short term. When you get into the cold and immediately after, one does experience an increase in core metabolism, you burn some calories, in other words, and while those might not be very significant increases, or I should say they can be statistically significant, but they are not enormously large numbers of calories burned, the longer lasting effects of deliberate cold exposure on metabolism seem to take place by changes that occur in the types of fat that we store in our body and the way that that fat impacts our metabolism at other times throughout the 24 hour cycle. This actually has a somewhat anecdotal basis, in particular in Scandinavia. I don't speak Swedish nor I speak Danish, nor do I speak Norwegian, but I do have Danish relatives and they were able to help me decipher a common Swedish saying, which essentially translates to the fact that in preparation for the summer, they say, one should expose themselves to warm environments so that one is comfortable in warm environments in the summer. That's one half of this traditional Swedish and also Danish saying. The other half of this traditional Danish-Swedish saying is that in preparation for winter, in order to not feel too cold in cold environments, one should prepare for those in the fall by not wearing a jacket and exposing one's self to cold environments. Now, of course, this is just anecdotal cultural lore, but it actually has a physiological basis, which is by exposing oneself to cold environments on a repeated basis in anticipation of exposure to more

extreme cold environments, one can feel more comfortable in those extreme cold environments. And that's exactly what they observed in this study by Søberg et al. The men felt more comfortable in extreme cold if they had trained through deliberate cold exposure, which might not seem surprising at all, but based on what we talked about earlier, whereby deliberate cold exposure evokes this discomfort and this experience of norepinephrine release, at least in the short term, then you would say, well, shouldn't that deliberate cold exposure also make them feel uncomfortable like they really want to get out? Well, that is true in the beginning of a deliberate cold exposure protocol, meaning in the first week or in the second week or the third week, but what one finds and what you will find if you do deliberate cold exposure consistently is that you will then become more comfortable at cold temperatures away from the deliberate cold exposure. So whereas you might have previously been the person who is always cold in the room with air conditioning, or always seeking a sweater, always wanting to bundle up, you will be more comfortable in those cold environments. And the reason for that is well substantiated from this study and from animal studies whereby deliberate cold exposure converts one particular kind of fat cell, the white fat cell, which is a very low metabolic output cell. It's basically a storage site for energy in the body fat cells to a different type of fat cell, which is the beige fat cell called beige because it's actually beige or slightly brown under the microscope, or even to brown fat cells, which are very dark under the microscope and dark because they contain mitochondria and are very metabolically and thermogenetically active. In other words, white fat doesn't burn many calories. It's basically a storage site. It's a bank account for energy. It's filled with lipids, and those lipids can be used if the body needs energy and if it goes into a caloric deficit. Beige fat and brown fat acts as sort of a furnace or the sort of fat that you would find in a kindle, a fuel that can increase core body temperature. So beige fat and brown fat is very good at raising our metabolism and helps burn white fat. Now of course, it does that only in the context of a caloric deficit, but it can actually help create that caloric deficit. Having more beige fat and brown fat can increase your overall core metabolism, in other words, the number of calories that you burn per day, and therefore the number of calories that you need to either maintain or to lose weight. The simple translation of this is that getting into cold water for a total of 11 minutes, perhaps more, but at least 11 minutes per week divided into two or four sessions can increase your core metabolism in part by increasing your beige and brown fat stores. And we know how that works at least in animal models and there's now reason to suspect that the exact same mechanisms are occurring in

humans. The primary way in which deliberate cold exposure converts white fat cells into these more metabolically thermogenetically active metabolism increasing beige and brown fat cells is because norepinephrine released when we get into the cold binds to receptors on the surface of white fat cells and activates downstream pathways such as UCP1, so this is an uncoupling protein one, that acts on the mitochondrial metabolism of cells and increases the mitochondrial output of those cells and the mitochondrial density of those cells. In other words, it takes a cell that has a kind of a weak engine or no engine for generating energy. Although every cell has some mitochondria, it takes cells that have very few mitochondria and increases the engine size. It kind of stokes the furnace of those particular cells and actually can change gene expression in those cells. So that's what's really interesting. Deliberate cold exposure causes increases in norepinephrine. which bind to receptors on the surfaces of white fat cells, which triggers the release of things like UCP1. It also causes the release of things like P-part gamma, and co-factor PGC1. I'm going to refer you to a review if you want to learn more about these. For those of you that don't want to learn more, all you need to know is that the downstream of all that are increases in mitochondria and metabolism and actual genetic changes in the white fat cells that convert them into beige and brown fat cells. This is especially important for adults because babies and young children actually don't have the ability to shiver or they have a less robust capacity to shiver. Very small babies really can't shiver so they have a lot of brown fat in order to keep them warm. Young children eventually develop the ability to shiver and maintain these brown fat stores, mainly around the clavicles, the heart, the upper spine, and in the upper back. And it's no coincidence that kids can often run around with a minimal of clothing and be comfortable in environments that adults would be cold in. As life goes on, we tend to lose beige and brown fat, but this mechanism that I'm referring to points to the plasticity of white fat, meaning the ability for white fat to actually convert its identity into this metabolically thermogenetically enhancing form of beige and brown fat. So deliberate cold exposure is a terrific way to increase your core metabolism and oftentimes critics will say, well, the increase in metabolism isn't that significant although I do want to point out again, the 93% and 350% increases in metabolism from that previous study. But critics then will say, well, that doesn't really translate to that big of a caloric burn during the deliberate cold exposure. But to that, you should say, ah, but that's only limiting your optics to just a portion of the effects of deliberate cold exposure because deliberate cold exposure can also convert white fat to beige fat and brown fat and lead to these more lasting increases

in metabolism. So for any of you interested in increasing your metabolism and or being comfortable in cold environments and or being comfortable in terms of being able to combat stress mentally, deliberate cold exposure, I do believe is a powerful tool. And there is simply no reason why you couldn't and shouldn't use the same protocols that I described earlier for building resilience to increase metabolism. Provided you're hitting that 11 minute per week threshold, you ought to be stimulating both mechanism increases in resilience and increases in core metabolism. As I mentioned earlier, most of the detailed studies on the conversion of white fat to beige fat and brown fat through the use of cold have been done in animal models, but the human data are starting to emerge. And if you'd like to do the deep dive into these mechanisms, things like UCP1, P-part gamma, et cetera, there's a beautiful review that was published recently in the journal cell, which is one of the three apex journals, nature, science, cell. And the title of that paper is adipose tissue plasticity in health and disease. I love this review. It has beautiful diagrams detailing all of the pathways from cold to norepinephrine through UCP1 downstream of things like cyclic AMP. If none of those names mean anything to you, don't worry about it. You certainly don't need to know these mechanisms to benefit from deliberate cold exposure protocols. If those names do mean something to you, or you are interested in exploring the downstream effects of deliberate cold exposure and something else that's really nice that's covered in this paper is how deliberate cold exposure interacts with fasted states and fed states. I think you'll also find this review very interesting. I don't want to go too deeply into fasted states and fed states right now, suffice to say that when we are fasted, meaning when we have an eaten for some period of time, our baseline levels of norepinephrine and epinephrine are already elevated. And so cold exposure at those times ought to have an even greater effect on metabolism and resilience and so on. So for you fasters or your intermittent fasters out there, if you really want to get fancy, you can do your deliberate cold exposure when you are fasted. I certainly wouldn't recommend doing it with a very full stomach in any case. And as I mentioned before on this podcast, intermittent fasting is, but one way, and certainly there are other ways to limit total caloric intake for sake of maintaining or losing weight if that's your goal. I know many people are using and benefit from intermittent fasting, however, and so it certainly can be combined with deliberate cold exposures in order

01:25:55 Tool: Caffeine, Dopamine & Cold Exposure

to get even greater increases in norepinephrine and epinephrine. So for those of you that are primarily interested in using deliberate cold exposure to increase dopamine levels in your brain and body, you can also do a combined protocol whereby you ingest caffeine 60 to 120 minutes before the deliberate cold exposure. This is based on a study that I've talked about before entitled caffeine increases striatal dopamine D-2, D-3 receptor availability in the human brain. And as the title suggests, this study was done on humans, looking at the density and or efficacy of these dopamine receptors in an area of the brain called the striatum, which is involved in planning in action and also suppressing planning in action. It's involved very closely with whether or not we can engage in behavior and withhold behavior, the so-called go and no go ways in the brain. Dopamine plays a critical role in that and many other things as well as you now know. So why would you want to ingest caffeine 60 to 120 minutes before deliberate cold exposure? Well, as I talked about earlier, dopamine can increase quite substantially in response to deliberate cold exposure, but dopamine on its own doesn't do anything, it has to bind to receptors and this paper shows quite definitively that ingesting caffeine in this case, it was 300 milligram dose of caffeine, which is about the dose of caffeine in two or three cups of coffee, it depends on the strength of the coffee, of course, but it's not an outrageous amount of caffeine, that increases the density and or efficacy of these receptors, which you would allow that dopamine to have its greatest effect. And for those of you that want to get really, really fancy, I suppose you could do this fasted so you get the further increase in norepinephrine, then you get the dopamine increase from the cold exposure, the binding of the dopamine. Although I do want to point out that at some point, you start layering together enough protocols that you would be spending your entire day trying to get this dopamine pulse and I would hope that you would have other activities that you would engage in, but if you're getting up in the morning and you're fasted because you haven't eaten all night and you have a cup of coffee, and then 60 minutes later, you take your cold shower or two hours later, you do your cold immersion or your cold shower, you would be layering together these different mechanisms of dopamine receptors, epinephrine and so forth in a way that at least to me, doesn't seem incompatible with having some other life like going to school and having relationships, et cetera. And this increase in dopamine, particularly in the striatum is not a trivial one. I do want to point out as the authors do that preclinical studies have shown that increases in striatal dopamine induced by things like modafinil, which is used to treat ADHD and treat narcolepsy, is necessary for their wake promoting actions. What this really says is that

just having elevated levels of dopamine from a drug or from an ice bath, or what have you is not sufficient to get the effects of dopamine, you really need the receptors to be available and you need those receptors to be available in the appropriate density and you need those receptors to be available in the appropriate density in the striatum in particular. So I think there are a number of reasons why if it's compatible with the other aspects of your health, cause of course always you have to consider this on a background of cardiovascular health and blood pressure, et cetera, that ingesting a cup or two of coffee

01:29:14 Tools: Increasing Metabolism w/Cold – The Sørberg Principle, Shivering

an hour before your ice bath may be fasted as well could be quite beneficial for increasing dopamine over quite extended periods of time. A couple of key points that you'll want to pay attention to in thinking about deliberate cold exposure and metabolism. In the Sørberg study, they also explored the use of sauna and how to use sauna, meaning deliberate heat in conjunction with cold. We are going to do an entire episode about the use of heat for health and performance. So that is not the focus now, however, it does raise an important point that we do need to address at this moment, which is if you are using sauna or if you are taking warm showers or if you are simply using deliberate cold exposure of any kind, should you get into the heat afterward or before or not at all? And this is where we can point to the so-called Sørberg principle, at least I call it the Sørberg principle, the Sørberg principle named after first author of this study, I referred to earlier, Dr. Susanna Sørberg. In science, it is appropriate to take a key piece of data and call it a principle if in fact it translates to something larger, which I believe it does. It is generally not appropriate for people to name a principle after themselves although there are a few scientists that have done that. So I have named it the Sørberg principle, but I did that to give it appropriate credit to Dr. Susanna Sørberg, who discovered that and pointed out quite appropriately, that to achieve the greatest increases in metabolism through deliberate cold exposure, you want to force yourself to reheat on your own after the deliberate cold exposure, meaning you wouldn't want to go from the cold shower to a hot shower or from the cold shower to a sauna. Rather if you were going to start with a hot shower or you're going to start with a sauna that you would end with the cold, and then you would reheat naturally. Now I personally take a cold shower a few times a week or do cold immersion and because I'm not specifically

focused on increasing metabolism, although I probably should be, that's not what I'm using it for now, I will take a hot shower afterwards and in doing so, I'm short circuiting some of the further metabolic increases that I would achieve were I to just end with the cold. So the Sørberg principle is if you want to increase your metabolism, end with cold, and we can take this a step further and say that if you want to use deliberate cold exposure to increase metabolism, that you should make sure that you get to the point where you shiver. And the reason in for this is that there are a series of studies, but in particular, one study published in the journal Nature, excellent journal in the year 2018, showing that deliberate cold exposure that evokes shivering from the muscles causes the release of a molecule called succinate from the muscles and that succinate plays a key role in activating brown fat thermogenesis, which you now have heard about and understand as critical to the increases in metabolism caused by deliberate cold exposure. So what this means is if you want to increase your metabolism, end on cold, that's a Sørberg principle and as best you can, try and get to the point where you are shivering either when you are in the cold exposure or immediately afterwards. Now one efficient way to do this is to, for instance, you could get into the cold shower for a minute or two minutes or three minutes, uncomfortably cold, but safe to stay in. Remember that's our general rule of thumb. Then turn off the water and stand there, make sure that you're not holding yourself close to your body, you're not hugging yourself to try and keep yourself warm, but rather your limbs are extended at your sides. And then if that fails to induce shiver than to turn on the cold water again, and then turn it off again, so alternating perhaps a minute to three minutes of cold exposure followed by a minute to three minutes of drying out in air and going back into the cold exposure, et cetera. I can tell you this from experience, this is a pretty brutal protocol. If you have never tried getting into an ice bath or cold water immersion or shower for one minute and then getting out and trying to stand there with your arms extended in cool or cold air for one minute, and then getting back into the cold shower or water immersion, you are in for an experience because even for those of you that are pretty shiver resistant, you'll find that it is much, much harder to get out of that cold water and stand there arms extended and drying off by evaporation, which further draws heat from the body than it is to wrap yourself in a towel, get in a warm shower or a sauna. So there's certainly no requirement to end on cold. There's certainly no requirement to induce shiver, but if your primary goal is to induce increases in metabolism, both in the short term and in the long term, following the cold exposure, well then you'll want to end on cold and you'll want to find a

way to shiver

01:34:15 Norepinephrine & Fat Cells

provided that the level of cold that you're exposing yourself to is still safe for you overall. So up until now, I've been talking about deliberate cold exposure as a potent stimulus for the release of norepinephrine in the brain and body and indeed it is, but the way I've been describing it has been in the context of circulating plasma levels of norepinephrine, meaning circulating within the blood. What I haven't mentioned, but is absolutely true is that the fat cells themselves actually receive input from neurons. So there are neurons that release norepinephrine in response to cold, directly into the fat. So I want to give you this picture of how the architecture of all this works, because I think it can help you navigate and indeed build better deliberate cold exposure protocols. Your adrenal glands release norepinephrine and epinephrine. Your brain has sites within it like the locus coeruleus that release norepinephrine and epinephrine, but there are also neurons within your skin that sense cold and other neurons that can directly release norepinephrine into the fat stores and cause those white fat cells to convert to beige and brown fat. And I think this particular aspect of our physiology is often overlooked in studies. And when people say, oh, well the increases in metabolism aren't that great, the circulating levels of norepinephrine, those are very large, but they're very transient and so on, that fails to understand that neurons that actually sense cold are in a position to communicate via other neurons directly to the fat cells and release norepinephrine into those fat cells, which as I pointed out earlier, set off a huge set of immediate and long term cascades of even gene expression changes. So the picture that I'd like you to have in your mind is that when you get into the cold, yes, of course you experience that as an experience of I don't want to do this, I'm going to overcome this, I'm going to climb over these mental walls that represent adrenaline release in my brain and body, but also that your fat cells are receiving signals,

01:36:22 Cold, Physical Performance, Inflammation

norepinephrine signals that are changing those fat cells and the way that they metabolize energy. Now I'd like to shift our attention to the use of deliberate cold exposure for sake of physical performance. And there are a lot of opinions out there

about the use of deliberate cold, whether or not it should be done for instance, before or after exercise, whether or not if done immediately after strength training or hypertrophy training, meaning training designed to grow muscles or make them stronger, whether or not it can inhibit that process and so on and so forth. I think today in looking over the literature and trying to bring forward the simplest and most straightforward, and yet scientifically grounded protocols, we can set up some general guidelines that will allow most, if not, all of you to still extract the benefits of deliberate cold exposure on physical performance without getting too neurotic about the exact timing, but for sake of discussion and because it's a prominent theme in many online communities, let's just start with the big one out there, meaning the question of whether or not doing an ice bath or doing deliberate cold exposure or taking a cold shower after strength slash hypertrophy training, meaning training designed to increase strength and or I should say the size of muscles will somehow short circuit or diminish that process, whether or not it will reduce or eliminate those strength gains and hypertrophy gains. And the short answer that I was able to arrive at on the basis of a review article that I'll talk about in a moment and some other studies as well, is that if your main goal is hypertrophy and strength, it is probably best to avoid cold water immersion and ice bath immersion in the four hours immediately following that strength and or hypertrophy training. Again, if your main goal is to achieve hypertrophy or strength or some combination of those, probably best to avoid cold water immersion up to the neck or ice bath immersion up to the neck immediately after strength and hypertrophy training and extending out to about four hours after that training. If you're really neurotic about this, then perhaps you'd want to move the cold water exposure to a different day entirely, but it all depends on how neurotically attached you are to getting every last bit of strength and hypertrophy. And if that's your goal, terrific, well then probably moving the cold exposure four hours or more away from that training is going to be necessary for you. Now you'll notice I did not talk about cold showers and the reason I did not talk about cold showers is that there simply are not very many studies of deliberate cold exposure through cold showers for the reasons I talked about at the beginning of the episode. It's hard for me to imagine that taking a brief cold shower after a strength or hypertrophy training session would completely reverse or short circuit the effects of that strength and hypertrophy training. But again, if you're neurotically attached to getting every last bit of strength and hypertrophy out of your training sessions, then by all means, err on the side of caution and wait four hours or more to do your cold shower just as you would wait four hours or

more to do your cold water immersion. Now there are nice data pointing to the fact that doing cold water immersion after a hard run, so endurance training, or even sprint and interval training or after a weight workout where your main focus is on performance of those movements or after a skill training workout where your main focus on performance of those movements, that there's no reason to think that that cold water immersion or ice bath or cold shower would inhibit the progress or the stimulus that would lead to progress that occurred during that training session. In other words, I don't see any reason based on the literature to avoid deliberate cold exposure immediately after training, again unless your goal is hypertrophy and strength. And in fact, there's a very nice review recently published on deliberate cold exposure and how it can impact physical performance, whether or not it's done before or after, different types of training and so forth. The paper is entitled impact of cold water immersion compared with passive recovery, following a single bout of strenuous exercise on athletic performance in physically active participants, a systematic review with meta-analysis and meta regression. So this is a meta-analysis of 52 studies that looked at a tremendous number of variables and contexts, as you would expect in a meta-analysis of 52 studies. I'm going to read you the conclusions of the study and I will provide a link. We certainly don't have the time to go through all the details of the study. I will highlight a few specific outcomes that I found particularly interesting, but here I am paraphrasing their conclusions, that cold water immersion, I want to emphasize immersion, not cold showers, but cold water immersion they say was an effective recovery tool after high intensity exercise. They observed positive outcomes, meaning improvements in certain variables, for muscular power, muscular soreness, meaning reduced muscular soreness, increased muscular power, perceived recovery after 24 hours of exercise. However, there were certain forms of exercise that were not benefited by cold water immersion, such as eccentric exercise, exercise focusing only on the lowering component or the so-called eccentric component of resistance exercise. They saw some very entry dose response relationships for things like endurance training, meaning the longer the cold exposure post-endurance training, the more improvement in endurance performance, reductions in circulating creatine kinases and things that relate to muscle damage under certain conditions. At some point in the future, by the way, we'll do an entire episode on creatine and creatine kinase, which are important not just for muscular function, but also for brain function. But the basic takeaway was that cold water immersion performed after high intensity exercise was beneficial from a number of different standpoints and

indicated that shorter duration, cold exposure and lower temperatures can improve the efficacy of cold water exposure if used after high intensity exercise. There I'm directly pulling from their conclusions. So what this says is that it's not just those longer duration, 30, 45 minute and 60 minute protocols of cold water immersion that we discussed earlier, but also shorter duration of one minute, three minute, five minute exposures to lower temperatures. Temperatures that would make you psychologically want to get out as soon as you possibly can, but again that you can safely stay in done after training really have been shown to improve outcomes in terms of reducing soreness and improving training efficacy, meaning your ability to get back into training more quickly and thereby deliver more training stimuli to a given muscle or in your endurance training protocol. Translate to English, what this means is that taking a cold shower or getting into an ice bath or some other form of cold water immersion within the immediate minutes or even the immediate hours following your training has been shown to be beneficial. I'm sure a number of you have questions for instance, how long should you be in that cold exposure? Is it the same as the 11 minute threshold described earlier? To be honest with you, there are not enough studies to really point to the critical threshold for eliminating or reducing delayed onset muscle soreness or for getting maximal results from power and endurance training, but this study does make a couple of key points and here I will just paraphrase. For instance, that cold water immersion is more likely to positively influence muscular power performance, to reduce muscle soreness, to reduce serum creatine kinase, and to improve perceived recovery after high intensity exercise, as compared with passive recovery. This can be translated to cold water exposure after training is beneficial and probably better than passive recovery from a number of standpoints. In addition, they say that dose response relationships meaning the amount and the degree of cold that people were exposed to and how often they did that in particular in lower temperature cold immersion. So these would be the sorts of cold immersion protocols that are one minute or two minutes, three minutes, maybe five minutes, but that one couldn't stay in there longer because it feels stressful and one wants to get out. Maybe more effective after high intensity exercise for removal of serum creatine kinase as well that these shorter duration cold water immersion approaches may be more effective after high intensity endurance performance as well. So all of this can be translated to say that unless your main goal is hypertrophy and strength, that cold exposure, ideally cold immersion and cold water ice bath, but if you don't have access to that, then cold showers is likely going to be beneficial if done immediately after

or in the minutes or hours after your training, especially high intensity training. One particularly nice thing about this meta-analysis is that it included some studies that involve the use of cooling packs. So again, vests that can essentially ice packs and indeed even cryotherapy chambers and so on. There's a nice table in the study if you want to get really detailed and go and look specifically at those studies, I invite you to do that. We'll put a link to this study in the caption for this episode, but all in all, what this study shows is that deliberate cold exposure can be very useful for recovery likely through reductions in inflammation, in muscle and connective tissue. And while this study did not look specifically at the mechanisms of reduced inflammation caused by deliberate cold exposure, those mechanisms are somewhat known. There are a number of studies that have pointed to the fact that deliberate cold and cold generally can reduce inflammatory cytokines, such as IL-6, interleukin six. It can increase anti-inflammatory cytokines such as interleukin 10 and so on. Without getting into all those details, I think it's sufficient to say that if you are somebody who experiences a lot of delayed onset muscle soreness, taking a cold shower after your training or getting into a cold immersion after your training, even if it's a few hours later ought to help. And if you are doing particularly intense training, then you probably want to ratchet up the number of cold exposure sessions that you're doing even if those have to be done on separate days from your training, because a lot of the inflammatory effects of training, endurance and strength training are actually occurring some hours away from the training stimulus. So it's not just that inflammation goes up radically during training, which it often can, but that it can occur even in the days and even weeks afterwards, depending how intense and how long duration that training is.

01:47:36 Hyperthermia & Glabrous Skin Cooling

So deliberate cold exposure is very powerful as an anti-inflammatory tool. Now I'd like to emphasize the topic that we touched on at the beginning of the episode, which are those glabrous skin surfaces, the hands, the upper face, and the bottoms of the feet through which heat is especially good at leaving the body. And another way of putting that is that one can cool the body much more efficiently through the glabrous skin surfaces. Now, if you want to understand all of the science behind this and all of the various applications, I invite you to please listen to the episode that I did with Dr. Craig Heller, again, in the biology department at Stanford. For sake of this episode, I'm just going to detail a couple

of findings from his laboratory. The first one, dealing with exercise induced hyperthermia, because I think this is very interesting and it can even save lives if you understand the way this works. There's a particular paper that focuses on this, and we will put a link to this as well. The title of this paper is novel application of chemical cold packs for treatment of exercise induced hyperthermia, a randomized control trial. This is a pretty brutal study, brutal for the subjects that is. This study involved was having subjects walk on a treadmill at a pretty significant incline and anywhere from nine to 17% wearing a substantial amount of clothing that was not well ventilated and the room was kept to 40 degrees Celsius, which is 104 degrees Fahrenheit. This is definitely not something to do at home. This study was designed to induce hyperthermia, which as I mentioned earlier, can be quite dangerous. And they compared two types of cooling. In the first form of cooling that they call traditional cooling, they had ice packs on their neck, in their armpits and in their groin. And in the other group, there was the so-called glabrous skin cooling. So the palms, the soles of the feet, which were actually so they were cooling inside the boots or inside of gloves and on the upper portion of the face. And the basic takeaway of this study is that by cooling the glabrous skin, the subjects were able to sustain this walking on these inclined treadmills for much longer than were the people who received traditional cooling. And also the return to baseline temperature was much faster in the glabrous skin cooling group. So how this translates to the real world is that if ever you are hyperthermic or someone else's hyperthermic, one way to cool them down quickly is to cool these palmer glabrous, soles of the feet glabrous and upper portion of the face glabrous portions of the body using cool rags, using ice packs or using any number of different cold objects or temperatures. One key thing, if you're going to use glabrous skin cooling, is that whatever you use to cool those surfaces cannot be so cold that it causes vasoconstriction. Because as I mentioned earlier, the arterio-venous anastomoses these portals of arteries directly to veins that exist only in these glabrous skin surfaces, the way that they're able to cool the body and essentially pass cool into the body although that's not really what they're doing, they're actually extracting heat from the body to be technical, they're extracting heat from the body, the only way they can do that is if those veins don't collapse and veins will collapse if they are made very, very cold. So if you want to use glabrous skin cooling to offset hyperthermia or for the other forms of performance, which we'll talk about in a moment, you need to use a cool object or surface that is not so cold that it causes vasoconstriction. And this can be a little bit tough to dial in, meaning it can be tough to identify such an object. And for that reason,

Dr. Heller and some of his colleagues have developed a commercial product called the CoolMitt. You can actually go to their website, coolmitt.com. I don't have any financial or other relationship to them. I know they've been developing this technology for some period of time. It involves a glove that you put your hand into, it circulates water of a given temperature and it does so, and does so at a temperature that is sure to not cause vasoconstriction of the palm. And you may be asking, how can you just put your hand into one glove and have this work? Well, that's how powerful these glabrous skin surfaces are. Even just by cooling one palm, the core body temperature drops radically. Now that's their commercial technology. I know that some people out there have started to experiment with a home version of this, which would be taking a package for instance of frozen blueberries or some other cold drink or cold metal object, and actually bringing it into the gym or out on a run. There are even people who are now developing cooled psych bicycle handles for long rides. This might seem a little kooky or crazy to you, but as you'll soon hear in the study I'm about to describe, the increases in endurance and in the volume of strength training that people can conduct if they appropriately cool their body through these glabrous skin portals is actually quite significant. So again, as it relates to hyperthermia, if someone is overheating by all means, try and get them out of that heat, get them to stop exercising, you can die from hyperthermia, try and cool the bottoms of the feet, the palms of their hands and the upper portion of their face. That does not mean it would be a bad idea to put cold water on the top of their head. That probably would also help and perhaps on their neck. What is probably not going to be a good idea is to do the more standard thing of draping someone in cold towels on the surface of their body because as I mentioned, the beginning of the episode, that thermostat in the hypothalamus,

01:53:27 Tool: Palmar Cooling & Endurance

the medial preoptic area will typically react to that by increasing core body temperature further. The effects of glabrous skin cooling on physical performance are truly remarkable provided the glabrous skin cooling is done correctly. And I want to point out that the main degree of effect is on volume or the ability to do more work. And I want to point this out because I think that many people, certainly in the exercise science community, but even in the general public, when they hear about some of these effects that are measured in the laboratory, they sort of look at those effects a bit of scans and

they think, well, that's not possible. Effects for instance, that have been documented showing doubling or tripling of the number of dips that one can do in a relatively short amount of time or doubling of the number of pullups one can do or 14% increases in strength or even comparable degrees in increase in weight training output to people who are on performance enhancing drugs, et cetera, et cetera. Part of the confusion is that the effects of proper palmer cooling, because it almost always is done by palmer cooling and less often in these experiments by cooling of the bottoms of the feet and the upper portion of the face, but those effects tend to be the ability to do more work over time and just to illustrate some of the major effects that the Heller lab is seen and they are document entered in this manuscript that I'll share with you in a moment. The typical protocol is to have people come in and do some endurance training so running on a treadmill and to have a condition where one group is actually doing palmer cooling while they are on a bike or on a treadmill and inevitably the outcome is that they can do more work. They can pedal further at a given speed, or they can run longer at a given speed than people who are not doing palmer cooling or who are receiving cooling by way of cold compress to the back of the neck or ice pack to the armpits, et cetera. So the effects of palmer cooling are very clear and very robust. And in the context of endurance exercise almost always allow people to do more work, to go longer with less perceived effort and to quit later so to speak. In terms of strength training, they've looked at the capacity to perform sets of dips. So one of the more famous examples of this that Dr. Heller shares in the episode that we did earlier, and that you can find at hubermanlab.com involves someone coming in and doing sets of dips, maybe 40 dips. This person actually could do 40 dips on their first set, then resting for a period of two to three minutes and then doing 35 and then resting for a period of two or three minutes, and then doing progressively fewer and fewer and fewer to the point where over a period of time, they add up the total number of dips that they can do and then they have them come back after a period of recovery, so not immediately after, but take a couple of days, come back and do effectively the same protocol, but during their rest periods, they're doing two minutes of palmer cooling, which essentially allows heat to move out of the body, lowering core body temperature in other words. And what they find is that they see enormous increases in the total number of dips that people can do, but that doesn't mean that the person goes from being able to do 40 dips, to being able to do 50 dips or 60 dips on that first set, what it means is they are able to do 40 on the first set, then 40 on the second, then 38 on the third and so on and so forth so that the total duration of

the workout is extended and yet they're doing much more work, even though it takes more time. So that's an important point and I think a point that perhaps wasn't as clear or as clearly made by me in the previous episodes that discuss this topic. For those of you that are interested in exploring palmer cooling, first of all, I recommend taking a brief glance or even a deep dive into this study, which is entitled work volume and strength training responses to resistive exercise improve with periodic heat extraction from the palm. In this study, they describe big increases in anaerobic, meaning strength training output, things like improvement in dips, improvement in bench press, improvement in pull-ups, et cetera, in human subjects. And it's a really nice study and points to some of the protocols that you might be able to adapt in your own setup. For instance, over six weeks of pull up training, palm cooling in between sets improved volume by 144%, and this was in experienced subjects. So that's interesting because a lot of studies of strength training and improvements in hypertrophy and strength are done in inexperienced untrained athletes, which changes the picture somewhat compared to experienced athletes. They found that strength, meaning the one repetition maximum, increased 22% over 10 weeks in bench press training. And they point to the particularly strong effects of using palmer cooling when people reach plateaus in endurance and strength training. And there, I think it's an important point. I think that if you're going to explore palmer cooling, it's probably not the sort of thing that you're going to do in every run or in every about of cycling or in every strength training session, but that it might be used to vastly increase your volume or vastly increase your endurance in a given session or a set of sessions in order to push through plateaus. A particularly interesting point in light of that is Dr. Heller has observed again and again that palmer cooling reduces delayed onset muscle soreness, or it can eliminate it entirely. And that's very interest because it also points to the fact that reducing core body temperature may somehow be involved in short circuiting the normal mechanisms of delayed onset muscle soreness. And you might say, well, how would temperature be involved in delayed onset muscle soreness? Well, I want to refer you back to the meta-analysis that we talked about earlier, where the short duration, very cold temperature exposure after training did indeed reduce delayed onset muscle soreness in part through reduction, excuse me, in creatine kinase. So it's not inconceivable that temperature and delayed onset muscle soreness are related. And that raises perhaps the most important point, which is the way that palmer cooling can improve performance by way of reducing core body temperature is known and that is because when one engages in exercise or

muscular output of any kind, strength or endurance exercise, the range of temperatures under which a muscle can perform is actually very narrow. There's an enzyme called pyruvate kinase, which is critical to muscle contractions and pyruvate kinase can only function in a very narrow range of temperatures. If that temperature gets too hot, meaning if the muscle heats up locally, whether or not by running or cycling or swimming or weightlifting, the ability for that muscle to continue to contract is reduced and eventually is short circuited completely. And I think this is a much underexplored or at least a much under discussed aspect of so-called muscular failure or the failure of one to continue to endure in running. So for instance, when you run as compared to a bench press or something, you don't stop running because you can't actually contract the muscles further, but somehow signals about the heating up of muscular tissue are conveyed to the brain. There's a crosstalk there, it's probably bidirectional and people stop, they quit. This is the quitting reflex. In strength training, one can no longer perform a repetition or set of repetitions in part because of heating up of the muscle locally. There are other mechanisms as well, of course, and I realize that, but what's very clear from the palmer cooling work is that by simply holding onto a cool object, remember not an object so cold that it constricts the vessels of the palms or constricts the vessels on the bottoms of the feet, but by holding onto a relatively cool object in one or both hands in between sets for two minutes or so, you can very efficiently reduce your core body temperature and in doing so, reduce the temperature of the muscles that are doing the work, increase the capacity for pyruvate kinase to continue to allow your muscles to contract and thereby allow you to do more volume of endurance and strength training. So a simple protocol that Dr. Heller passed to me is find a relatively cool object. So you could, for instance, fill two bottles with cold water, maybe put a few ice cubes in there. This is not exact because we're not talking about the commercial CoolMitt product here, we're talking about an at home version or use a pack of frozen blueberries or broccoli sort of pack of those as what he described. And then in between sets to put your hands and ideally you'd put the bottoms of your feet, but that's not always feasible in most gyms where they won't let you take off your shoes and so forth, but to put the palms of your hands on that cool surface for a minute or two minutes between sets and then returning to your sets of work. Now, if you are heating up through other mechanisms like you're wearing a stocking cap and you're in a very warm environment, this might not have as potent effect as if you were to do this cooling in a more moderate environment, wearing lighter clothing, et cetera. So by all means warm up to do your exercise,

lubricate your joints, and get into a place where you're not going to injure yourself, doing whatever form of exercise you do. But then if you'd like to explore palmer cooling, I know a number of people who've written to me saying they heard about palmer cooling on the episode with Dr. Heller. They've tried this and they see quite excellent results. It does take some discipline. It's one thing to just kind of hang out in the gym and play on your phone in between sets. It's another to do deliberate cooling with your palms or the bottom of your feet or the upper portion of your face. You might get some weird looks, but of course you'll be the one doing significantly more volume, not experiencing delayed onset muscle soreness and achieving

02:03:18 Cold Exposure to Groin, Increasing Testosterone

better endurance and strength gains were you to do this properly. Now as a final topic related to the use of deliberate cold exposure for improving health and performance, I'd like to touch on this theme that exists online, on social media, on YouTube and in various fitness communities of using deliberate cold exposure to the groin, in particular to the testicles, in order to try and increase testosterone. And while this might sound really kooky, indeed this practice exists. Indeed if you were to go onto Amazon, there are actually ice pack underwear that are being marketed for sake of increasing testosterone. Now, I am not aware of any specific well-controlled studies that show that this indeed works. I can imagine based on what I know about the nervous system, testosterone and cold, et cetera, that there are a couple of mechanisms by which one might experience increases in testosterone as a consequence of deliberate cold exposure. First off, let me say there is no reason why you would have to apply these ice packs in the way that I just described. One could of course take a cold shower. One could of course use cold immersion of various kinds, and you're still going to get that exposure of the groin and the testicles to cold. Now I should point out that people do report at least anecdotally increases in testosterone as a consequence of this practice and I have to imagine that they are measuring their serum testosterone, that they're not just guessing that their testosterone went up. If you know of a study exploring this directly, please let me know, put in the comment section on YouTube, or even just email me. We have a email that you can find it, hubermanlab.com. Please email me the reference. I wasn't able to find a reference, but I can imagine two reasonably plausible mechanisms by which deliberate cold exposure to the groin, in particular the testicles, would increase testosterone. The

first is somewhat direct, which is that anytime you cool a body surface, that if it's cold enough, you're going to get vasoconstriction. And then subsequently you're going to get a rebound increase in vasodilation, meaning you're going to constrict the blood vessels in that area. And then after the cold is removed, there's going to be more blood flow to that area. And of course, blood flow relates to organ health and tissue health generally. So perfusion of that region and the gonads to be specific with additional blood, you could imagine in some ways increasing testosterone, that's reasonably plausible. The other probably more likely mechanism relates to the dopamine increases caused by cold exposure that we talked about earlier. Again, anytime you have a somewhat stressful stimulus, but in particular with cold exposure, it seems that the catecholamines, norepinephrine, epinephrine and dopamine all increase and dopamine is known to be in the pathway that can stimulate testosterone. And so while there isn't a direct relationship between dopamine stimulating testosterone, there is an interesting pathway whereby dopamine increases can trigger increases in things like luteinizing hormone, which can trigger increases in testosterone as well as estrogen for that matter. So I know that there are a lot of people out there that are interested in the use of cold exposure for increasing testosterone. And some of those people in communities are indeed using cold exposure directly on the gonads, on the testes in order to do this. I'm not certain that that direct contact is necessary. And in some cases it might actually be quite dangerous or you at least should be careful in terms of tissues there and avoiding damage. But nonetheless, I think that a dopamine impact on testosterone is very likely given the 250% increases in dopamine that have been observed with cold water immersion and all of that points to the fact that cold water immersion very likely increases testosterone, but as a downstream consequence of the cold water immersion effects on dopamine and luteinizing hormone, and again there's no reason to think that the increases in luteinizing hormone would also increase estrogen. Probably not to dangerous or levels that one would want to avoid, but I don't think that there's anything particularly specific about cold for inducing testosterone and not other hormones. I think it's very likely to increase a number of different hormones. I do hope that there will be a systematic study on this in the not too distant future.

02:07:50 Tool: Optimal Timing for Daily Cold Exposure

I also hope to not be a subject in the cooling of the gonads experiment. Now I promise

you the last topic was the last topic, but there's one other really important point that I think everyone should be aware of if you're going to use deliberate cold exposure. And that brings us back to the very first thing that we discussed today, along the lines of deliberate cold exposure, which is that your baseline temperature is going to be lowest about two hours before you wake up, it's going to increase in the morning and as you wake up and increase throughout the day and afternoon, and then start to drop in the evening and come down at night as you head to sleep. I also want you to remember that if you are to cool the external portion of your body, in particular your torso, the net effect of that is going to be an increase in body temperature. So for many people, not all, but for many people, if you are going to do deliberate cold exposure, you are going to increase your core body temperature and that makes sense if you think about how deliberate cold exposure can increase metabolism by increasing thermogenesis. What that all means is that if you are doing your deliberate cold exposure early in the day, you are going to get yet a further increase in core body temperature that would be associated with wakefulness, your ability to be alert that morning or throughout the day and so on. It also means that if you do your deliberate cold exposure very late in the evening, or at night, so 6:00 PM, 7:00 PM, 9:00 PM and so on, you are going to increase your core body temperature and if you recall, a decrease in core body temperature of one to three degrees is not just beneficial, but is necessary in order to get into deep sleep and remain in deep sleep. So the takeaway from this is deliberate cold exposure done properly will increase your core body temperature and make you feel more alert. So if you're doing it early in the day, that's probably terrific given that most of us want to be alert during the day. However, if you do it too late in the day, evening or night, it can disrupt sleep by way of disrupting your core body temperature. Now, the caveat to that is I myself tend to do deliberate cold exposure early in the day. Maybe not first thing in the morning, but mid morning, maybe as late as three or four in the afternoon in some cases. In the longer days of summer, I might do it even later, five or 6:00 PM and have no trouble sleeping. I have done deliberate cold exposure very late at night, 10:00 PM, 11:00 PM and so on as part of a 30 day challenge of doing deliberate cold exposure every day for 30 days and I got sloppy with my timing and then in order to not miss a day, I would do it at 11 o'clock at night. And I must say I found that I could still fall asleep very easily, even doing deliberate cold exposure very late at night. However, on those particular days, I was particularly busy and so I was particularly exhausted when I arrived at the deliberate cold exposure and I had no trouble falling asleep after doing

deliberate cold exposure, and then taking a nice warm shower and then going to sleep. But I could imagine that because of the increases in core body temperature caused by deliberate cold exposure, that were one to do that too late in the day, evening or night that it could indeed disrupt your sleep. So my recommendation would be for most people only do deliberate cold exposure if you are prepared to be fairly alert for the next one

02:11:16 Neural Network Newsletter, Zero-Cost Support, YouTube Feedback, Spotify Reviews, Apple Reviews, Sponsors, Patreon, Thorne, Instagram, Twitter

to four or maybe had been six hours following that deliberate cold exposure. So for today's episode, as is the case with most episodes of the Huberman Lab Podcast, I covered a lot of material. We talked about mechanisms of catecholamines and stress and pulsatile release of epinephrine, metabolism, mental effects, performance, glabrous skin cooling and on and on and on. And while the goal of course is to make sure that everyone arrives at specific, very clear mechanistic and actionable protocols, I do realize that it is an immense amount of information. And for that reason, I've created a list of deliberate cold exposure protocols aimed at improving mental toughness and resilience, mood, performance, metabolism, reducing inflammation, and so on and so forth. All of those have been condensed into succinct form and can be found at the Huberman Lab Neural Network Newsletter. This is a monthly or semi-monthly newsletter that we release that includes takeaways from the podcast and protocols. You can access those as protocols zero cost by simply going to hubermanlab.com, signing up for the neural network newsletter. It's very easy to do, you just supply your email and you will receive the newsletter. We do not share your email with anybody else. In fact, we have our privacy policy laid out on the hubermanlab.com website so you can find that there and the protocols that I've designed should make it very straightforward for you to create a set of protocols that you could use with cold showers, with cold immersion, with or without ice in combination with exercise specifically for one goal or another, or to accomplish multiple goals simultaneously. If you're learning from and or enjoying this podcast, please subscribe to our YouTube channel. That's a terrific zero cost way to support us. In addition, please subscribe to the podcast on Spotify and or Apple and on Apple, you have the opportunity to leave us up to a five star review. You can also now leave reviews on Spotify so we'd appreciate if you would do so. If you have suggestions for future guests or topics that you would like us to cover or feedback generally for the

Huberman Lab Podcast, please put that in the comment section on YouTube. Please also check out the sponsors mentioned at the beginning of today's episode, that is the best way to support this podcast. In addition, we have a Patreon, it's patreon.com/andrewhuberman. And there you can support the podcast at any level that you like. On many previous episodes of the Huberman Lab Podcast, we talk about supplements. While supplements aren't necessary for everybody, many people derive tremendous benefit from them, for things like sleep and focus and other aspects of health and performance. One issue with the supplement industry that's very serious, however, is that these supplement companies simply do not use high quality ingredients or the amounts of the ingredients they list on the packaging does not match what's actually contained in their product. For that reason, we partner with Thorne, T-H-O-R-N-E, because Thorne supplements are known to be of the very highest quality ingredients and the very highest degree of specificity in terms of the amounts of the ingredients that are listed on the packaging accurately match what's contained in their products. If you'd like to see the Thorne products that I take, you can go to Thorne, that's thorne.com/u/huberman. And there, you can see the Thorne products that I take and get 20% off any of those products. In addition, if you navigate deeper into the Thorne site, through that portal, Thorne, thorne.com/u/huberman, you can also get 20% off any of the other products that Thorne makes. If you're not already subscribed to Huberman Lab on Instagram and Twitter, please do so. There I cover science and science related tools that sometimes overlap with the content of the podcast, but oftentimes is distinct from the information covered on this podcast. So thank you once again for joining me in the discussion about the use of deliberate cold exposure for health and performance and last but certainly not least, thank you for your interest in science.