Transcribed by readthatpodcast.com

The Science & Health Benefits of Deliberate Heat Exposure | Huberman Lab Podcast #69

I describe the mechanisms by which deliberate heat exposure impacts body temperature, metabolism, heart health, hormone production, exercise recovery, cognition, mood, and longevity. I detail specific protocols for deliberate heat exposure, including exposure times, temperature ranges to consider, time of day, and delivery mechanisms (sauna vs. hot bath vs. open air heat, etc.) in order to achieve different specific outcomes, including dramatic growth hormone releases, or reduction in cortisol levels. I also discuss the ability of locally applied heat to heal or otherwise improve various bodily tissues and new data on how local application of heat may induce the conversion of metabolically sluggish white fat to metabolically robust beige fat.

#HubermanLab #Sauna

Thank you to our sponsors
LMNT: https://drinklmnt.com/huberman
InsideTracker: https://insidetracker.com/huberman
ROKA - https://www.roka.com - code \"huberman\"

See Andrew Huberman Live: The Brain Body Contract
Tuesday, May 17th: Seattle, WA
Wednesday, May 18th: Portland, OR
https://hubermanlab.com/tour

Our Patreon page
https://www.patreon.com/andrewhuberman

Supplements from Momentous
I am pleased to announce that the Huberman Lab Podcast is now partnered with Momentous. Momentous supplements are of the very highest quality; each is third-party tested for purity and accuracy of dosage. To learn more about the Huberman Lab Podcast-Momentous partnership, the supplements I that take, and stay up-to-date with future product announcements, visit: https://www.livemomentous.com/huberman

Transcribed by readthatpodcast.com

Social & Website:
Instagram - https://www.instagram.com/hubermanlab
Twitter - https://twitter.com/hubermanlab
Facebook - https://www.facebook.com/hubermanlab
TikTok - https://www.tiktok.com/@hubermanlab
Website - https://hubermanlab.com
Newsletter - https://hubermanlab.com/neural-network

Subscribe to the Huberman Lab Podcast:
Apple Podcasts: https://apple.co/3DbFdlv
Spotify: https://spoti.fi/34Xod5H
Google Podcasts: https://bit.ly/3wo01EJ
Other platforms: https://hubermanlab.com/follow

Article Links
Sauna bathing is associated with reduced cardiovascular mortality and improves risk prediction in men and women: a prospective cohort study: https://bit.ly/3EIC6C4
Endocrine Effects of Repeated Hot Thermal Stress and Cold Water Immersion in Young Adult Men: https://bit.ly/3LiREPt
Endocrine effects of repeated sauna bathing: https://bit.ly/3kaSD8C
Growth hormone response to different consecutive stress stimuli in healthy men: is there any difference?: https://bit.ly/3rNhSBU
Sauna Bathing and Risk of Psychotic Disorders: A Prospective Cohort Study: https://bit.ly/3vJN6Lg
Local hyperthermia therapy induces browning of white fat and treats obesity: https://bit.ly/3vFhLto

Timestamps
00:00:00 Heat & Health
00:03:37 Momentous Supplements
00:04:52 The Brain-Body Contract
00:05:46 LMNT, InsideTracker, ROKA
00:09:31 Body Shell Temperature vs. Body Core Temperature

Transcribed by readthatpodcast.com

00:13:28 Thermal Regulation, Hyperthermia
00:17:36 Heat Removal Circuits, Pre-Optic Hypothalamus (POA)
00:26:30 Protocols & Benefits of Deliberate Heat Exposure
00:33:37 Tools & Conditions for Deliberate Heat Exposure
00:38:47 Deliberate Heat Exposure, Cortisol & Cardiovascular Health
00:44:50 Heat Shock Proteins (HSPs), Molecular Mechanisms of Heat Regulation
00:47:56 Longevity & Heat Exposure, FOXO3
00:52:30 Deliberate Cold & Heat Exposure & Metabolism
00:54:48 Deliberate Heat Exposure & Growth Hormone
01:04:32 Parameters for Heat & Cold Exposure
01:08:26 Circadian Rhythm & Body Temperature, Cold & Heat Exposure
01:12:00 Heat Exposure & Growth Hormone
01:16:20 Tool: Hydration & Sauna
01:17:10 Heat, Endorphins & Dynorphins, Mood
01:28:44 Tool: Glabrous Skin To Heat or Cool
01:35:33 Local Hyperthermia, Converting White Fat to Beige Fat, Metabolism
01:47:00 Hormesis/Mitohormesis & Heat/Cold Exposure
01:49:11 Benefits of Heat Exposure
01:51:10 Zero-Cost Support, YouTube Feedback, Spotify & Apple Reviews, Sponsors, Momentous Supplements, Instagram, Twitter, Neural Network Newsletter

Disclaimer: The Huberman Lab Podcast is for general informational purposes only and does not constitute the practice of medicine, nursing or other professional health care services, including the giving of medical advice, and no doctor/patient relationship is formed. The use of information on this podcast or materials linked from this podcast is at the user's own risk. The content of this podcast is not intended to be a substitute for professional medical advice, diagnosis, or treatment. Users should not disregard or delay in obtaining medical advice for any medical condition they may have and should seek the assistance of their health care professionals for any such conditions.

Title Card Photo Credit: Mike Blabac - https://www.blabacphoto.com

- 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 talking about the science of heat, and more specifically the science of heating, the verb, meaning how our body heats up from both the outside and the inside. Heat is a remarkable stimulus, meaning when we are in a hot environment, it has a profound effect on our biology. And heating up from the outside, or as you'll soon learn, from the inside, has a profound effect on many different aspects of our health, including our metabolism, both in the immediate and long term; our cognition, meaning our ability to think more or less clearly. And if you're immediately thinking that heating up makes you less capable of thinking, you're wrong. Heat applied properly as a stimulus can engage certain neurochemical systems in your brain and body that can allow your brain to function far better. We will talk about those data today. So we're going to talk about the science of heat and heating, both in terms of their mechanisms. And, as I know many of you are interested in, the tools related to the use of heat, things like sauna, how often to do sauna, how long to be in the sauna, how hot to be in the sauna for particular goals and outcomes. We're also going to talk about the very exciting new science around local heating. That is the use of heat applied to specific areas of the body in order to heal or improve tissues at that location that you are heating as well as your biology and health overall. In fact, we are going to talk about one very recently published paper that came out in the journal Cell. Cell is one of the three apex journals, meaning three of the most competitive, most rigorous scientific journals. Those are Nature, Science, and Cell. This particular paper was published in Cell, and I will go into it in more detail later, but basically what this paper shows is that by locally heating up skin and fat, you can change the identity of certain fat cells at that location and elsewhere. We have three kinds of fat, white fat, beige fat, and brown fat. And as you will learn more about soon, white fat is not very metabolically active. It's more of a fuel reserve. It's what we typically think of as blubbery fat. Beige fat and brown fat are rich in mitochondria, and those mitochondria provide a sort of furnace or heating mechanism for your entire body and increase your metabolism and the burning of white fat. So in other words, having more beige fat and brown fat is a good thing. And it turns out that the proper application of heat to specific areas of your body can increase the conversion of white fat to beige fat. In other words, turn an innocuous fuel source into a metabolically active tissue that can help you burn off more white fat. I think many people are going to be interested in this paper and the tools that emerge from this paper. It's a fascinating set of findings that actually emerged from an understanding of the biology of burn and people who receive intense burns. And that is

not what I'm going to recommend to you as a tool, of course, but understanding a little bit about how burns impact our biology and health has allowed these pioneering researchers to develop new tools to combat

00:03:37 Momentous Supplements

obesity and metabolic disorders, and that you can apply for basic things like fat loss. I'm pleased to announce that the Huberman Lab Podcast is now partnered with Momentous Supplements. Our motivation for partnering with Momentous is to provide people one location where they can go to access the highest quality supplements in the specific dosages that are best supported by the scientific research and that are discussed during various episodes of the Huberman Lab Podcast. If you go to livemomentous.com/huberman, you'll see those formulations. I should mention that we are going to add more formulations in the months to come, and you'll see specific suggestions about how best to take those supplements, meaning what dosages and times of day, and in fact, how to combine those supplements with specific behavioral protocols that have been discussed on the podcast and are science supported in order to drive the maximum benefit from those supplements. And many of you will probably also be pleased to learn that Momentous ships not just within the United States, but also internationally. So once again, if you go to live momentus.com/huberman, you will find what we firmly believe to be the best quality supplements in the precise dosages and the best protocols for taking those supplements,

00:04:52 The Brain-Body Contract

along with the ideal behavioral protocols to combine with those supplement formulations. I'm pleased to announce that I am hosting two live events in May 2022. The first live event will take place in Seattle, Washington on May 17th. The second live event will take place in Portland, Oregon on May 18th. Both are part of a lecture series entitled The Brain Body Contract, during which I will talk about science and science-based tools, many of which overlap with the topics covered on the Huberman Lab Podcast, but most of which will not and will be completely new topics and tools never discussed publicly before. Both live events will also include a question and answer period, during which you, the audience, can ask me questions directly about any aspect of science or

science-based tools, and I will attempt to answer them. Tickets for the two events, again, Seattle on May 17th and Portland on May 18th,

00:05:46 LMNT, InsideTracker, ROKA

are both available at hubermanlab.com/tour. 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 LMNT. LMNT is an electrolyte drink that has everything you need and none of what you don't need, meaning sugar. It has electrolytes, and the main electrolytes are sodium, potassium, and magnesium, which you need in the proper ratios in order for your brain and body to function correctly. LMNT was designed to get you the proper ratio of electrolytes in order to optimize mental and physical performance. People out there with pre-hypertension and hypertension, of course, should be cautious about increasing their sodium intake. But many people can actually benefit from increasing their sodium intake, both for health and for performance. LMNT contains a science-backed electrolyte ratio of 1000 milligrams. That's one gram of sodium, 200 milligrams of potassium, and 60 milligrams of magnesium. I consume LMNT when I first wake up in the morning, during exercise, and after exercise, and sometimes again, if I've been sweating profusely, for instance, after doing a sauna or taking a run on a hot day, things of that sort. If you'd like to try LMNT, you can go to drinklmnt, that's lmnt.com/huberman to claim a free LMNT sample pack. You only cover the cost of shipping. Again, that's drinklmnt, lmnt.com/huberman to claim a free sample pack. Today's episode is also brought to us by InsideTracker. InsideTracker is a personalized nutrition platform that analyzes data from your blood and DNA to help you better understand your body and help you reach your health goals. I've long been a believer in getting regular blood work done for the simple reason that many of the factors that impact your immediate and longterm health can only be analyzed from a quality blood test. There are a lot of blood and DNA tests out there, but a major issue with many of them is that you get numbers back about levels of hormones, metabolic factors, lipids, et cetera, but you don't know what to do with that information. InsideTracker has solved that problem by creating a personalized dashboard. So you take your blood and or your DNA test, you get the results back, and where certain values

might be too high or too low for your preference you can click on that, and it will direct you immediately to lifestyle factors, nutrition, and supplementation, et cetera, that can help you bring those numbers back into the ranges that are ideal for you. So it not only gives you information about where your health stands, it gives you directives as to how to improve your health. If you'd like to try InsideTracker, go to insidetracker.com/huberman to get 20% off any of InsideTracker's plans, that's insidetracker.com/huberman to get 20% off. Today's episode is also brought to us by ROKA. ROKA makes eyeglasses and sunglasses that are of the absolute highest quality. I've spent a lifetime studying the visual system, and I can tell you that your visual system is incredibly sophisticated. It allows you to do things like move from a shady area outside to a sunny area outside and to adjust your visual system so you don't even notice that transition. A lot of sunglasses and eyeglasses are not designed with those sorts of biological transitions in mind. ROKA sunglasses and eyeglasses are different. Every one of their glasses is designed with the biology of the visual system in mind. First of all, they're incredibly lightweight, so you don't even notice that they're on your face. Second of all, they were designed to be worn during activities like running and cycling, et cetera, and they won't slip off your face even if you get sweaty. And they have a terrific aesthetic. So even though they were originally designed as active eyewear, they look great. So you can wear them out to dinner, to school, at work, et cetera. If you'd like to try ROKA sunglasses or eyeglasses, you can go to ROKA, that's roka.com,

00:09:31 Body Shell Temperature vs. Body Core Temperature

and enter the code Huberman to save 20% on your first order. Again, that's ROKA, roka.com, and enter the code Huberman at checkout. Okay, let's talk about heat, more specifically, let's talk about the biology of heat and heating and the health benefits and tools related to heat and heating. The first question that we have to answer is how do we heat up? And the answer to that question is we heat up two ways. We heat up from the outside, meaning the things that we come into contact with, the clothing that we put on our body, whether or not there's heat in the room, or whether or not it's cold outside or cold in a room, and we heat up from the inside. Our body has the capacity to generate more heat or to cool down, meaning to turn off the heating process, and it can do that in ways that match the external environment. The simplest way to think about this is that we actually have two body temperatures. People will say, "Oh, what's body

temperature? "98.6." That's actually not true. Body temperature varies between individuals. It varies across time of day within individuals. And at every point across your entire lifespan, you have two distinct temperatures. One is the temperature on your skin, what scientists call your shell, and the temperature of your core, your viscera, meaning your organs, your nervous system, and your spinal cord. And as you can imagine, the temperature of your core is always higher than the temperature at your surface. So the important thing to know is that you have a temperature at your shell and a temperature at your core. Now you don't need to know exactly what those temperatures are in most cases, but it is vitally important to understand that you have those two temperatures and that your brain is constantly sending out signals to your body as to whether or not it should heat up or cool down, depending on the temperature of the shell, which makes total sense. This is a lot like a thermostat in a room, which is essentially paying attention to how cold or hot it is, and then sending signals to the heating or cooling system to either heat up the environment or cool down the environment, depending on the temperature in that environment. Your brain has neurons that send signals to other cells in your body and deploy the release of chemicals in your brain and body to heat you up when you are too cold and to cool you down when you are too hot. So, if you can understand that you have two body temperatures, one at your shell, the surface, and one at your core, inside, and that your body and brain are always trying to balance those two temperatures in the appropriate way, well then you're halfway there to understanding the biology of thermal regulation and heating, and you'll be a lot further along in understanding how specific tools can be used to improve metabolism or improve cognition, for instance. In fact, later you will learn that one way that you can heat up is by cooling down the surface of your body. That's right. If I were to throw a cold towel, ice cold towel, onto your torso right now and ask you, "Well, how do you feel?" You'd say, "Oh, that's cold, that's chilly." However, because your brain is acting like a bit of a thermostat as the surface, the shell of your body felt cool, it would make sense that that thermostat would activate biological mechanisms that would heat up your core. Similarly, if I were to put you into a very hot environment, you'd say, "Oh, wow, it's really, really warm in here," but your brain and your body would go through a lot of effort to activate mechanisms to cool you down. So anytime we're talking about heat, meaning deliberate heat exposure, things like sauna, it's very important to understand, not just the stimulus, how hot something is, how long you're in a sauna, et cetera, but the effect that has on your shell and on your core. If you can understand that you can design protocols that are

literally perfect for your goals. And as a final point about this, if you want to develop the best tools,

00:13:28 Thermal Regulation, Hyperthermia

leveraging heat for your biology and health and performance, you want to understand heat as a process, as a verb, as heating, not just heat, because there's the temperature that you are at before you encounter the heat stimulus, before you get in the sauna, for instance, during the heat stimulus, so while you're in the sauna, and then afterward. Everything in biology is a process. So as you'll soon learn, there is a specific sauna protocol that can allow you, can allow anybody, in fact, to increase the amount of growth hormone released into their brain and body 16 fold. That's right, 16 fold. However, it involves shifting from a hot environment to a cool environment, to a hot environment, to a cool environment, over and over and over again, over a very short period of time, because it engages a switch, a process, that compounds, it builds on itself, to increase growth hormone further and further. In fact, if you were to just get into a sauna for a very long period of time and crank up the temperature to match the exact temperature that was used in that study, you would not experience those increases in growth hormone. It really is the transition between hot and cool temperatures that engage the process of heating and reheating over and over again. So, today you're going to learn about the use of sauna. You're going to learn about the use of other heat-related tools for health and optimization, not just for growth hormone, but also metabolic health, for controlling cortisol, even to impact mental health in positive ways. And in order to do that, you need to understand a little bit about the mechanisms of how you heat up and how you cool down, where the cells and circuits are in the brain and body, how those cells and circuits work. I promise to make the description of that which follows very clear, even if you don't have a background in biology. And once you have that in hand, along with the understanding you now have about the fact that you got a shell and a core, and you need to think about both the shell and the core, well, then you will be in the best possible position to use sauna or hot tub or other tools, even just a hot shower, as a powerful stimulus to optimize your biology. Now, the science of heat and heating and cold and cooling, for that matter, goes back well over a hundred years. In fact, it's kind of amusing to me that nowadays there's a kind of renewed interest in the use of heat and cold and the science of heat and cold, because this was the first topic that I studied as an

undergraduate. And in fact, I did my graduate thesis on thermal regulation. And at the time, thermal regulation wasn't really considered one of the hot topics in neuroscience. People were more focused on things like memory and consciousness. And of course those topics are still of vital interest to many people in many laboratories, but thermal regulation was considered more a thing for the physiologists. Nowadays, not just on social media, not just in the landscape of biohackers and athletes, but in the landscape of mental health, and frankly, in the general ethos around health optimization, people are really interested in heat and cold. And the reason they're so interested in heat and cold is that a lot of the science has been done both in animal models in mice and in humans and translates immediately to protocols that anyone can use. Now, a brief warning now and another brief warning later, anytime you're talking about heating up your body, you need to be very cautious, because unlike cooling down, where you have a fairly broad range of cold temperatures that you can go into before it's damaging to tissue, well, you don't get to heat up the brain and body very much before you start getting into the realm of neuron damage, and neuron's in the central nervous system, the brain and spinal cord, once they're damaged they don't come back. So hyperthermia is a serious thing to avoid. Later I'll talk about ways to rapidly protect against hyperthermia, but I do want to give everybody a cautionary note up front. Obviously, if you're pregnant, nursing, if you're very sensitive to hot environments, you want to stay out of saunas and things of that sort. I'm sure there are exceptions to that. You definitely have to talk to your doctor if you're going to violate that rule. And for everybody, you want to approach any kind of tool related to heating very cautiously. You always have the opportunity to increase the temperature later. So proceed with caution.

00:17:36 Heat Removal Circuits, Pre-Optic Hypothalamus (POA)

Be smart about it. I don't just say of that to protect me. I say that also to protect you. So now let's talk about what are the circuits for heating up? How does that happen? Many of you have probably experienced a fever. How does that happen? What happens when you go into a cold environment and you're shivering, but you put on a coat and then you feel warmer. What's really going on there? Well, there's a very basic circuit, meaning neurons that exist in the skin, in the brain, and in the body that communicate with one another that allow you to heat up if you need to and cool down if you need to. I'm going to throw a little bit of nomenclature, a few new words at you. You don't need to memorize

these words, except for one, actually you need to memorize one acronym, but it's very easy. It's called the POA. If you remember POA, you'll be home free for the rest of the episode, but I know that there are some aficionados out there and people interested in getting a little bit deeper mechanism. And I do think it's important to understand the circuit, because once you stand this circuit and the way it's structured, then you are going to be in a great position to use the tools related to heating. So here's how this circuit is structured. You have this shell, which is basically skin, and within the skin you have neurons, nerve cells. Those nerve cells have channels or receptors on them. They're called trip channels. There's some other ones as well, which basically sense changes in heat. So if I were to put a hot object on your hand or your arm, or for instance, if I were to put a hot object on your hand or arm, and then remove that hot object, those neurons would respond to that. They would send electrical signals into your spinal cord. And that's where the next station of the circuit resides. In your spinal cord you got a little cluster of neurons that exists at the top part of your spinal cord called the dorsal horn. The name, again, doesn't matter. And those neurons specifically relay heat information up to another area of your brain. Now here's where we get into some fancy names. It's the lateral parabrachial area. You don't need to know lateral parabrachial area, but it's a relay station. The lateral parabrachial area sends electrical signals to the POA. And I would like you to know POA. The POA stands for preoptic area. Neurons in the preoptic area basically reside over the roof of your mouth. These are neurons within the hypothalamus, and neurons in the preoptic area have the ability to send signals out to the rest of your brain and body to get you to heat up and actually to change your behavior so that you heat up. That's right. If neurons in the preoptic area receive an electrical signal through the circuit I just described, that goes from skin to dorsal horn of the spinal cord, to lateral parabrachial, they will start sending signals out to the organs of your body and the tissues of your body to get those organs and tissues to do things. And believe it or not, your POA, your preoptic area, will actually change the way that you think and feel immediately. For instance, if something warm contacts your skin, or something very hot contacts your skin, the preoptic area will send signals out to the endothelial cells, the blood vessels both of the brain and body that get them to dilate, to essentially increase their volume and their surface area in order to cast off heat. You will also start sweating. That sweating response is initiated, not by the hot day or the hot sun, but by the preoptic area neurons that send signals out to what's called the periphery of your and other chemicals are released, things like acetylcholine, that get you to sweat.

And if you happen to be shivering, neurons in the preoptic area will make sure that you stop shivering. You're probably familiar with the feeling of being somewhat lethargic, or spreading out your limbs on a hot day. Well, that is the result of neurons in your preoptic area impacting your musculature to get you to increase your surface area so you can sweat off or release more heat. So there are all these different mechanisms by which we dump heat. Some of those are purely physiological, below our conscious control, things like sweating, which you can't just make yourself sweat on demand. Maybe you can through a set of stressful thoughts, but you can't just make yourself sweat. That is autonomic, it's below your conscious control. Things like vasodilation, the dilation of your veins in particular and capillaries in particular. These sorts of things. And, of course, there are these behavioral, somewhat voluntary aspects of dumping heat. And the lethargy, the kind of tiredness that we feel on a really hot day, that's also controlled by the circuit that I just described. In fact, I just got back from a visit to a very warm place, and it was remarkable to me how lethargic I felt in the afternoons. I just felt like a total slug. I just could not move or rally to do anything, except if I waited until the evening, even though it was later in the day, even though I hadn't napped, as the temperature in my environment cooled off, as my body temperature cooled off, I felt like I had more energy. I was actually waking up, even though I had been awake for longer. So the relationship between temperature and lethargy is a very intimate one. If we're warm enough, we feel active and like we want to move around. If we're too warm, we feel like we need to stay put and spread out our limbs and dump heat. And that brings me to a quick and kind of fun point about how we dump heat versus how other animals dump heat. Many of you know, of course, that we dump heat by sweating. Other mechanisms as well, some of which I described, but that's our main way of dumping heat. Other animals like dogs don't have the capacity to sweat, at least not very much, so they pant in order to dump heat. And still other animals, like rodents, when they get too hot they spit on their paws and they rub that spit on the surface of their body, which might sound kind of gross, and probably will get you to think twice before petting any of those animals or holding any of those animals again, unless that's your thing. Now, one other key thing to understand about this circuit related to heat is that the preoptic area also can send electrical signals to the amygdala, a brain area that is often talked about in the context of fear, but is really just a brain area that can activate your sympathetic nervous system. The sympathetic nervous system is part of your autonomic nervous system and is the one associated with fight or flight, or with the stress response, or even just the excited

response. The sympathetic nervous system is also what gets activated when you're really excited about something. The preoptic area has the opportunity to trigger the activation of the amygdala. Now, it doesn't do it every time, but it can. And it tends to do that when you are suddenly in an environment that feels too hot, that you feel is risky levels of hot. If you ever have gotten into a sauna that was very, very hot, maybe 210 degrees Fahrenheit, you sit there for a minute. You'll notice that your heart rate increases, and there are reasons for that, and we'll talk about some of the health benefits of that in a few minutes, but it's pretty uncomfortable. You may not feel like your skin is going to burn up, but you often will feel the impulse to get out, especially if you stay in there for a little while. That impulse is the consequence of this preoptic area communicating with your amygdala saying, "Hey, this environment is really hot, and I'm tryin' to cool down, and it's not really working. I'm dumping heat, but I'm not able to adjust the core of my body temperature in ways that are going to protect my neurons. And so it's a signal that you probably shouldn't stay in that environment too long. Now later we'll talk about the advantage of pushing yourself a little bit through some of these very hot environments, provided you can do it safely, but the impulse to get yourself out of a very hot environment is the consequence of the POA communicating with your amygdala, and the amygdala then, in turn, activating your adrenal glands, which sit right above your kidneys, the release of adrenaline, and this feeling of agitation like you want to move. Usually you want to move out of whatever hot environment you happen to be in. So now you know the circuit. Again, it's simple. It goes from skin to spinal cord, one brain area to another brain area. That's the key one in this discussion, which is the POA, the preoptic area. And then the preop area can kick off a bunch of autonomic subconscious responses to heat, which make us attempt to get cooler, things like sweating, vasodilation, et cetera, and it can kick off behavioral responses, spreading out our limbs in an attempt to dump even more heat; feeling lethargic, so a lack of desire to run and move; and it also has the opportunity to kick off a mild, or maybe not so mild, panic response to get us out of that hot environment. If you can conceptualize that circuit, or if you can even just understand what I just said, even at a top contour level, you're going to be in a great position

00:26:30 Protocols & Benefits of Deliberate Heat Exposure

to understand the rest of the information and the tools that follow. Next, I'd like to talk

about the use of deliberate heat exposure, including sauna, but other tools as well, as a way to understand how heat and heating changes our biology. So, you're going to learn some mechanism and you're going to learn some tools. But first I'd like to just emphasize that the use of deliberate heat exposure can be a very powerful way to improve health and longevity. There's a wonderful study on this that was published in 2018 that includes a lot of data from a lot of participants, in a lot of different conditions, for instance, people that only did sauna once versus two to three times a week versus four to seven times a week and so on, and compares all those. The title of the study is Sauna Bathing is Associated With Reduced Cardiovascular Mortality and Improves Risk Prediction in Men and Women a Prospective Cohort Study. This is one of several papers that clearly demonstrate that regular use of sauna or other forms of deliberate heat exposure can reduce mortality to cardiovascular events, but also to other events, things like stroke and other things that basically can kill us. What I like so much about this and the related studies, and yes, I will provide a link to these in the show notes, is that they involve a lot of participants. So for instance, in this particular paper, which was published in BMC Medicine, they looked at a sample of 1,688 participants who had a mean age of 63, but there was a range of ages around 63, and of whom 51.4% were women. The rest were men. So it's a pretty nicely varied study in terms of the populations that they looked at. And basically what they found was the more often that people do sauna, the better their health is and the lower the likelihood they will die from some sort of cardiovascular event. What do we mean by sauna? We need to define some of the parameters around sauna, and I promise to provide you some alternative ways to access some of the health benefits that were observed in this and related studies without the need to have a sauna, 'cause I do realize that a lot of people don't have access to sauna. First off, the temperature ranges that were used in this and pretty much all the studies that I'm going to talk about, unless I say otherwise, are between 80 degrees Celsius, meaning 176 degrees Fahrenheit, and 100 degrees Celsius, meaning 212 degrees Fahrenheit. So somewhere in that range. How hot should you make the sauna or the environment that you get into should you decide to use these tools? Well, that will depend on your tolerance for heat, how heat adapted you are. Yes, some people are better at sweating than others. And over time we all get better at sweating. Meaning if you go into the sauna more frequently, you become a better sweater, not sweater you wear, but the verb sweater, you get better at sweating, at dumping heat through the loss of water. So it's going to depend. I recommend starting on the lower end of the temperature scale,

and if that's too hot for you that you even lower the temperature further. Now, how long were people exposing themselves to these hot environments? Anywhere from five to 20 minutes per session. And as you'll soon learn, very brief periods of just five minutes of heat exposure can be a powerful stimulus if the heat exposure is significantly great enough for you. 20 minutes can also be beneficial, but 80 to 100 degrees Celsius, meaning 176 degrees Fahrenheit to 212 degrees Fahrenheit is the general range that this and most studies use. In this particular study, they compared the effects of people that did sauna once a week, two or three times per week, or four to seven times per week. And what they saw was really remarkable. What they observed was that people who went into the sauna two or three times per week were 27% less likely to die of a cardiovascular event than people that went into the sauna just once a week, again at the temperature levels and the duration that I talked about earlier. And as you can imagine, the duration, the temperature levels were related. So if people went into very hot environments that were really uncomfortable for them, maybe they only went in for five minutes. Whereas, if they were more comfortable and heat adapted in a given environment or their tolerance for heat was just simply higher for whatever reason, well then they tended to stay in longer. We can take a sort of average of this five to 20 minute range, and today we're mainly going to talk about exposures between 10 and 20 minutes at temperatures between, again, 80 degrees and 100 degrees Celsius, 176 degrees Fahrenheit, or 212 degrees Fahrenheit. So these data point to the fact that going in the sauna two or three times per week is really beneficial and can lower mortality to cardiovascular events. And in fact, the benefits were even greater for people that we're going into the sauna four to seven times per week. Those people were 50% less likely to die of a cardiovascular event compared to people that went into the sauna just once a week. So these are really impressive, and frankly, encouraging studies. Certainly they caught my eye and encouraged me to start using deliberate heat exposure on a regular basis. What's particularly nice about this study, and the related study that, again, is linked in the show notes, is that they looked at a number of potentially confounding variables, things like whether or not people smoked, things like whether or not people were overweight, whether or not they tended to exercise or not exercise, and they were able to separate out those variables. So the percentages that I described earlier, 27% less likely to die of a cardiovascular event for those that went in the sauna two to three times a week and 50% less likely to die of a cardiovascular event for those that went into the sauna four times per week, as compared to just once a week. Those effects really do

seem to be the consequence of the sauna exposure and not some other effect that's correlated with sauna exposure, like going to the gym where people are working out seven times a week and then also happen to get into the sauna, or quitting smoking right about the same time they adopt a sauna protocol, these sorts of things. And now there have been additional analyses of the use of sauna for improving health, or I should say for offsetting mortality, that have found that it's not just reductions in cardiovascular events, but so called all-cause mortality. This is kind of medical geek speak for saying, how likely are you or somebody to die from a cardiovascular event, but maybe be also from some other event, some other health-related event, like cancer or something of that sort. And in every case, regular exposure to sauna starting at about two or three times per week, all the way up to seven times per week, greatly improves, meaning statistically significant improvements in longevity in the sense that people are less likely to die of cardiovascular events and other things that kill us. So I and many other people who are interested not just in our own health, but in educating about health-related tools

00:33:37 Tools & Conditions for Deliberate Heat Exposure

to the general public, find this really exciting. But knowing what we know about how heat impacts our biology, it probably shouldn't surprise us that this sauna type exposure or deliberate heat exposure has these incredible effects. So before we get into the biological mechanisms of how heat can have all these impressive health effects, I want to just talk about the use of sauna as a tool and emphasize that you don't have to use a sauna in order to get these benefits. It is simply a matter of making sure that your shell and your core heat up properly a bit, not too much, not too little, but that you heat those up. And no, you do not need to carry a thermometer around or place a thermometer into your core. In laboratory studies and in humans, if you really want to know someone's core temperature, basically you try and put the thermal probe as close to the core as you can. So typically that's done rectally or a mouth thermometer or even up the nose. You don't need to do any of that. This isn't a laboratory study. There are ways to create a hot environment such that you heat up your shell and your core safely without having to measure your core temperature all along. If you want to do that, be my guess, but I'm not going to provide a protocol. So the question is, how are you heating up your environment? And I realize that there are dry saunas, there are steam saunas, there are infrared saunas, there are hot tubs, and there are simply rooms that you crank up the

heat. There are also ways in which you can increase your shell and your core temperature by moving around a lot and doing that wearing a lot of clothing. There's nothing special about any one of these approaches or protocols. It just so happens that sauna is one of the more convenient ways to do this. And certainly for the studies that I've talked about, not just the ones I referenced before, but all the studies that I researched looking at this episode, it makes sense why they would use sauna, because it's very hard, for instance, to create conditions where you have five people go out jogging, wearing heavy sweaters and hats, wool hats on the middle of summer, it's very hard to set up those conditions in a way that's controlled for everybody. Whereas, it's pretty straightforward to have a sauna where you have one or several people just get into that one uniformly hot environment. That's a much easier study to run. So just to be clear, the temperature range is important. You want to get between 80 and 100 degrees Celsius. Now you know the conversion to Fahrenheit. You could, however, immerse yourself in a hot tub or hot water bath up to your neck. That's another way to approach it. If you didn't have access to either of those, you could also put on a hoodie or a wool hat and a hoodie, or you could do like the wrestlers do, and you could actually buy one of these plastic suits. They're literally called plastics that wrestlers or other athletes that wish to drop water weight will wear, and then go jogging in that. All of those will increase your shell and your core body temperature. Especially if you do it on a hot day, but of course be careful, hydrate and don't overheat. Don't become excessively hyperthermic, 'cause you can get heat stroke and you can potentially die. But if you're going to use sauna, often I get the question how hot should the sauna be? Well now you know. How long should you be in there? Five to 20 minutes per session. Although, I will talk in a minute about ways to optimize hormone output, in particular growth hormone output, by doing four very brief sessions. So maybe not a continuous session. We'll get into that in a few minutes. And, of course, you have to ask yourself wet sauna, dry sauna. You know what? Doesn't matter. Use what you prefer. Many people ask me, "Well, what about infrared sauna?" We have an entire episode all about the use of light and low level light therapy, including infrared light. It does have certain benefits for skin and other organs and tissues of the body, if used properly. My understanding, or at least my assessment, of most infrared saunas out there is that they don't get hot enough. They don't get up to that 80 to 100 degrees Celsius range. Some do, most don't. So what you end up with is a situation where you've got a red light, low level light therapy stimulus, and you've got a sauna that's not quite hot enough. And there are a lot of ideas and claims about how

they work together in order to get you improved benefits. I personally am of the stance, based on the literature that I've read, that you want to get into those ranges of 80 to 100 degrees Celsius before you start considering whether or not you're also going to include red light therapies, et cetera. So there's nothing special about red light sauna. It's really the temperature of the sauna that you happen to get into. So which tool? Which sauna? Which stimulus? Do you run wearing plastics and a hoodie and a wool hat or do you get into a sauna? That's going to depend a lot on your circumstances, your budget, and what you have access to on a regular basis. This is a lot like our discussion about the use of cold. Most of the studies have looked at immersion in cold water up to the neck, because that's a very controlled situation that you can do in a laboratory. They have not explored cold showers as much, So there's just less data, or walking around in a cold environment. But we'll talk a little bit about those data,

00:38:47 Deliberate Heat Exposure, Cortisol & Cardiovascular Health

because as you'll soon learn, when you talk about cold, you're actually talking about heating as well. So what kind of mechanisms are activated in your brain and body that allow for the various health benefits of sauna or other forms of deliberate heating? Well, we talked about reduced risk of cardiovascular event related mortality and all-cause mortality. As you'll soon learn, there are also tremendous benefits in terms of increases in growth hormone, reductions in cortisol, et cetera. I will detail those. So what happens when you do get into a hot environment? What are the mechanisms that allow for the various health effects of that? Well, your shell, your skin, senses that. And through the circuit that I described earlier, activates neurons in the POA, the preoptic area, which in turn activates mechanisms in your autonomic nervous system, like vasodilation. So blood flow increases. Plasma volume of your blood increases, and stroke volume. The volume of blood that is mobilized with each beat of your heart also increases. And your heart rate increases to anywhere between 100 to 150 beats per minute. That general constellation of effects looks a lot like cardiovascular exercise. And in fact, for all intents and purposes, it really is cardiovascular exercise, except that there isn't the mobilization and the loading of joints and limbs and things of that sort. And of course there are additional benefits of cardiovascular exercise that relate to impact on the ground, improvements in bone density, et cetera, et cetera. But basically your heart starts beating, more blood starts circulating, your vasculature changes shape, literally, to

accommodate those increases in heart rate and blood volume. And you're basically getting a cardiovascular workout in that hot environment, even if you're just sitting down. Another set of positive effects related to being in these hot environments are hormone effects, shifts in the output of hormones, both from or your adrenals and possibly from the testes and ovaries and even within the brain. One of the more striking examples of that comes from a study that was published in 2021. The title of the study is "Endocrine Effects of Repeated Hot Thermal Stress "and Cold Water Immersion in Young Adult Men." And indeed, this study was, in this case, just done on men. I'll just briefly describe the protocol they used. They had these men attend four sauna sessions of 12 minutes each. So again, well within that range of five to 20 minutes, 12 minutes. The temperature of those saunas was 90 to 91 degrees Celsius. So I'll just quickly do the calculation, admittedly, not in my head. That's 194 degrees Fahrenheit, and they did that four times. Afterwards they had a six-minute cool down break during which they did get into some cool water or cold water of about 10 degrees, which is, 10 degrees Celsius is 50 degrees Fahrenheit. And then they measured hormones at various times throughout this study, before, during, and after. They looked at testosterone, they looked at DHEA, which is in the androgen pathway. They looked at prolactin and they looked at cortisol. The significant effects of the protocol that I just described were on cortisol, a so-called stress hormone. So-called because when we are very stressed for long periods of time, cortisol levels tend to increase dramatically. But I should point out that a increase in cortisol each day right about the time of waking, and specifically right about the time of waking, is actually beneficial for our alertness and our energy. So having some increasing cortisol every 24 hours is a good thing, provided it happens early in the day. Late day increases in cortisol are associated with depression. That's been shown by studies at Stanford and elsewhere. The major effect of this study is a significant decrease in cortisol output in these subjects. I think this is really interesting and important, because many people suffer from acute, meaning immediate, and longterm stress, and are looking for ways to control their stress. Controlling your cortisol is tricky. In the episode on stress, I talked about supplements such ashwagandha that can be used to limit cortisol, but you have to be careful not to use ashwagandha for extended periods of time, meaning for longer than two weeks, because you can get into other issues. I talk about breath work protocols that can allow you to clamp or reduce the stress response in real time. Again, see that episode for those, but many people are overworked. They're overstressed. They're, for one reason or another, they're subjected to many too many

stressors or their level of stress resilience isn't high enough to keep their cortisol levels clamped at a healthy level. So the protocol I described of 12 minute exposures to 90 degree environment, that's again, 90 degree Celsius, followed by a six-minute cool down break in cool water, 50 degrees or so, that's pretty cold. I can imagine that you could also just take a cool shower or a cold shower afterwards, that had a very significant effect on lowering cortisol. So there you have a tool that's not a completely zero cost tool, 'cause you need to heat the water and you need to have access to hot and cold water, at least hot and cold contrast of some sort, but it's fairly minimal cost for most people. Especially if you start getting creative about maybe taking a 12-minute jog wearing a lot of clothing if it's hot out, then getting into a cool shower. You might not get the same extreme or significant reduction in cortisol that was observed here with these very specific protocols, but it's likely that you would get a similar result over all. Now, I mentioned they did look at these other hormones, and I'll just tell you that they did not see significant shifts in testosterone, prolactin, DHEA, et cetera, using this protocol. As you'll soon see, there are other sauna protocols that can impact those other hormones. So if you're seeking to use sauna to reduce stress, I think this is a very interesting and potentially useful research-backed protocol. And again, we will provide a link to the paper if you'd like to read more about the data. So that is one set of biological effects on cortisol

00:44:50 Heat Shock Proteins (HSPs), Molecular Mechanisms of Heat Regulation

and the related protocol. What about some of the other benefits of sauna? Well, we'll talk about those, but I want to talk about those in the context of the underlying mechanisms, because if you understand those underlying mechanisms, you can really tailor your sauna protocols for your particular needs. One of the more dramatic and important effects of going into a hot environment for some period of time is the activation of so-called heat shock proteins, or HSPs. Heat shock proteins are a protective mechanism in your brain and body to rescue proteins that would otherwise misfold. What do I mean by this? Well, most of you're familiar with the fact that if you have protein in the kitchen, like a steak or a piece of chicken or a piece of fish, and you heat it up, it changes it's texture. Raw meat is different than cooked meat, to be quite blunt about it. Heat changes the quality of proteins, not just in terms of how they taste, but the way in which they are configured. It changes it right down at the molecular level. When your body goes through

changes in temperature each day, and we'll talk about those changes, but in response to hot environments or cold environments, heat shock proteins are deployed to go and rescue and prevent the changes in proteins that would be detrimental to your health. So at least in the short term, activating heat shock proteins is a good thing. You don't want heat shock proteins to be activated for long periods of time, because that gets to be problematic for other reasons. But these heat shock proteins, of which there are many varieties, basically have the job of traveling in your brain and body and making sure that cells that contain proteins that are misfolding because they got heated up too much, don't misfold, and they also, sort of a protective mechanism, making sure that proteins within the cells of your brain and body don't fold in the wrong ways. Again, I'm describing this in very general terms, but it's well established in animal models and in humans, that sauna exposure of the sort that I described earlier activates these heat shock proteins. There's some interesting studies that were carried out in animal models that really nicely mechanistically support the role of heat shock proteins in some of the benefits of deliberate heat exposure. Some of these studies were done in flies, meaning Drosophila, fruit flies, 'cause there are great model organism, because you can delete genes or add genes easily. Other studies have been done in mice. And now there are also studies being carried out in humans, and I will talk about those. One of the more dramatic examples that's always touted in this field of deliberate heat exposure as it relates to longevity is that if they expose these flies, these fruit flies to 70 minutes of a heat stimulus that would, obviously didn't kill them, but activated heat shock proteins, it could extend their life by 15% in a heat shock dependent way. Meaning if they made flies that didn't have these heat shock proteins, well then they didn't see this extension in life.

00:47:56 Longevity & Heat Exposure, FOXO3

And this is one of the reasons to use model organisms. This is not an experiment that you could do in people. However, there have been interesting studies done in humans, examining some of the downstream molecular pathways of deliberate heat exposure that point to the mechanisms by which deliberate heat exposure can help protect against different forms of mortality, improve overall, and possibly, and I want to highlight possibly, possibly extend life. One such mechanism involves a genetic program involving a molecule called FOXO3. FOXO3 is a very interesting molecule, because it's involved in DNA repair pathways. DNA repair is part of the process of remaining healthy. We'd all

like to think that we're born, and based on the genes we have, we are healthy, healthy, healthy, then eventually we age and then we die. But from the time we're born, until the time we die, there's a constant repair of our proteins in our cells in a modification of the genes that are being expressed, puberty being the most dramatic example. You see a kid before puberty and after puberty, looks like a different kid, sounds like a different kid, thinks like a different kid. In fact, it basically is a different human being. It's not just the hormones. It's that hormones themselves have the capacity to turn on and turn off certain genes, literally converting certain tissues and cells in the brain and body to do entirely different things. So it's not just the sprouting of new aspects of our biology. It's literally the conversion of different brain centers from one function to another. That's puberty. And we'll do a whole episode about puberty. We actually did an episode on sexual development that talks a little bit about those mechanisms. But the point is that throughout our entire lifespan, genes are being turned on, genes are being turned off. Genes are being turned on. Gene are being turned off. And DNA, the stuff of genes, gets damaged in that process. FOXO3 sits upstream in a pathway related to DNA repair, and again, clearing of the senescent cells. Sauna exposure, in particular sauna exposure two to three times or ideally four to seven times per week in that 80 to 100 degree Celsius range has been shown to upregulate levels of FOXO3. FOXO3 in turn upregulates pathways related to DNA repair and clearing out of these senescent or dead cells, which is known to be important for various aspects of maintaining cognition and other aspects of maintaining health. So these are the likely biological mechanisms for the improvements in lifespan, or rather, I should say, these are the biological mechanisms that apparently offset some of the cardiovascular risk and other forms of mortality that were described earlier. One especially interesting thing about FOXO3, there are individuals out there that have either additional copies of FOXO3 or who have versions of FOXO3 that are hyperactive, so to speak, those people tend to be 2.7 times more likely to live to 100 years of age or longer. So these are people that were just naturally, and fortunately for them, endowed with more FOXO3, more clearance of senescent cells, more DNA repair, et cetera. For the rest of us, at least to my knowledge, I don't have one of these health-promoting FOXO3 mutations. Remember, mutations can be beneficial or they can be detrimental. This, if your goal is to live longer, is a beneficial mutation. If you don't have these FOXO3 mutations that allow you to be a centenarian at 2.7 times high or likelihood than other people, deliberate heat exposure is one way that you can increase FOXO3 activity. At this point in time, meaning when looking at the

research out there, it isn't clear what the optimal sauna protocol is going to be, specifically to increase FOXO3, and that's probably because there isn't one. There is no sauna protocol designed specifically to reduce cortisol or specifically to increase FOXO3 or specifically to activate heat shock proteins. Any deliberate heat exposure is likely to impact all of those mechanisms. Again, I encourage you to use this guide of 80 to 100 degrees Celsius as your kind of bookends for what you can tolerate and where you want to start and eventually transition to in terms of deliberate heat exposure. And I would encourage you to use

00:52:30 Deliberate Cold & Heat Exposure & Metabolism

that five to 20 minutes per session for the sauna as your rough guide of how long to remain in this sauna. Now, there was a study published just this last year that was mainly focused on deliberate cold exposure. I detailed this quite extensively in the episode on cold. This is the beautiful work of Susanna Søberg. And that study looked at deliberate cold exposure, but also sauna exposure. And that study found that 57, yes, 57 minutes per week of sauna exposure in conjunction with 11 minutes per week total of deliberate cold exposure was the threshold for getting improvements in metabolism and increases in brown fat, this very active fat tissue that improves mitochondrial function and thermogenesis, meaning heating of the body. We'll talk more about brown fat later. Why do I mention this? Well, for those of you that are interested in increasing metabolism, it does seem to be most beneficial to do that 11 minutes per week of cold exposure, again, divided up across two or more sessions. So it's not 11 minutes all at once, but shorter sessions, and to get 57 minutes minimum per week of sauna exposure, again, in the temperature ranges that I've talked about here. And again, it's not 57 minutes in the sauna all at once. That's 57 minutes total per week as the minimum threshold. So you might divide that into three sessions of 20 minutes. And again, I don't think 57 is the magic number. It could be 60, it could be 64. It probably could be 55. Remember your biological systems are not counting things off minute by minute, second by second, least not in most cases. So for those of you that are interested in improving metabolism, check out the episode on cold, or just take the Søberg Protocol, as I call it, which is 11 minutes total per week of uncomfortably cold, but safe, cold exposure. So uncomfortably cold means you really, really want to get out of the shower or the ice bath or whatever environment, but you can stay in, 11 minutes

total per week divided across a couple sessions and then 57 minutes per week, or so, of deliberate heat exposure, again, uncomfortably, but uncomfortably hot, excuse me, but safe to stay in, probably divided up across three or more sessions. Okay, so we've talked about the use of sauna to decrease cortisol. We've talked about the use of sauna

00:54:48 Deliberate Heat Exposure & Growth Hormone

to increase heat shock proteins. We've talked about the use of sauna to increase FOXO3. Now I'd like to talk about the use of sauna to increase growth hormone. Growth hormone is a hormone that we all naturally secrete from our pituitary, which also resides near the roof of our mouth. The signal for the pituitary to release growth hormone arrives from neurons that exist in the hypothalamus. So growth hormone releasing hormones, believe it or not, that's what they're called, stimulate the release of growth hormone from the anterior pituitary gland into the general circulation, and then growth hormone impacts metabolism and growth of cells and tissues of the body. It is responsible for tissue repair as well. And the growth spurt that everyone experiences during puberty is the consequence of growth hormone. What I'm about to describe is a study that found dramatic, really dramatic I should say, increases in growth hormone, but I also want to emphasize that these increases in growth hormone were not of the sort that are observed in puberty or in infants becoming adolescents or adolescents growing into teenagers. Those levels of growth hormone that are associated with those massive transformations, excuse me, of body morphology, of shape, are far greater than the sorts that I'm talking about here. And yet, as all of us age, when we go from adolescence to our teenage years and then into a young adulthood, but then starting in our early 30s or so, the amount of growth hormone that we secrete is greatly diminished. Normally we would release growth hormone every night, after we go to sleep, in particular in the early part of the night when our sleep is comprised mostly of slow-wave sleep. As we age, less growth hormone is released during that slow wave sleep. There are various things that can promote the release of growth hormone, and we will talk about some of those other things in a moment, things like low blood sugar, turns out, is a stimulus for growth hormone release. And I don't mean hypoglycemia of the sort that makes you dizzy and want to pass out. That's bad. I mean, not having high levels of glucose and insulin in your bloodstream. This is one of the reasons why many people are drawn to intermittent fasting or even prolonged fasting, it's because of the reported increases in growth

hormone. I'll touch on those briefly, but if you want to learn more about those and what their real impact is and the extent of growth hormone, check out the episode I did on fasting. You can find that at hubermanlab.com. Certain forms of exercise have also been shown to stimulate growth hormone release. And in a few moments, I'll talk about how exercise and fasting can be combined or how heat can be combined with exercise or certain patterns of food intake to further increase growth hormone. But before I do that, I want to review some of the data, and one study in particular, that discovered certain forms of deliberate heat exposure using sauna can stimulate very large increases in growth hormone output, which for people in their 30s, 40s, and beyond could be very useful, and may also be useful for people who are just trying to stimulate the release of more growth hormone in order to, for instance, recover from exercise or stimulate fat loss or muscle growth or repair of a particular injury. The title of this paper is "Endocrine Effects of Repeated Sauna Bathing." And this is a paper that was published in 1986, which is some years ago, but nonetheless serves as a basis for a lot of other studies that followed. So let me describe what they did in this study. They used an 80 degree Celsius environment, so that's 176 degrees Fahrenheit, and they had subjects do the sauna for 30 minutes, four times per day. So that's two hours total in one day, 30 minutes in the sauna, a period of cool down rest, 30 minutes in the sauna again, cool down rest, a third, and a fourth time. So, two hours total in this 80 degree Celsius environment. So that's a lot, but what they observed was really quite significant. So they had subjects do this protocol, and I should mention they had both male and female subjects in this study, and the entire study lasted a week. They did this two hours of sauna exposure on day one, day three, and day seven of that week. And they measured a lot of different hormones, cortisol, thyroid stimulating hormone, thyroid hormone itself, luteinizing hormone, and follicle stimulating hormone, which are hormones that essentially drive the production of other hormones. We won't get into that too deeply, but if you'd like to learn about FSH, follicle stimulating hormone, and luteinizing hormone, please see the episode on optimizing testosterone and estrogen at hubermanlab.com. They looked at prolactin and they looked at growth hormone. I'll just cut to the chase and tell you the effects on growth hormone. In subjects that did this two hour a day, 80 degree Celsius protocol experienced 16-fold increases in growth hormone. So they measured growth hormone before the sauna and after the sauna and growth hormone levels went up 16 fold, which is obviously an enormous, and it turns out statistically significant, effect. Now, one important caveat here. Remember earlier when I talked about people who did sauna

once a week versus two to three times a week versus four to seven times a week, and the more often people did sauna, the less likely they were to die of cardiovascular events or other things of that sort? Well, in this case, the effects of sauna exposure on growth hormone actually went down the more often that people did this deliberate heat exposure. So as I mentioned, they did this two hour a day divided into 30 minute sessions protocol on day one, day three, and day seven of a week. And what they found was on day one, there was a 16-fold increase in growth hormone. On day three, however, there was still a significant effect on growth hormone as compared to before sauna, but that effect was basically cut by two thirds. So now instead of getting a 16-fold increase, it was more like a three or four-fold increase, which is still a huge increase, but not as great as the increase observed on day one. And then on day seven, there tended to be a two, maybe a threefold increase, but not as great as the one observed on day one. What does this mean? And why does this happen? Well, the reason this happens is because heat, just like cold, is a shock or a stressor to the system. In the context of cold, if you get into a very cold ice bath, for instance, a five-degree ice bath, even for 20 seconds, it's known to increase norepinephrine 200%. It can double the amount of norepinephrine that you suddenly release into your brain and body, which actually can have some positive effects. I'll talk about those in a little bit, but if you were to do that every day, you would become cold adapted. This circuit that compares the shelling core of your body would adjust in ways that it could either predict that cold stimulus, or more likely to create some thermogenetic mechanisms in preparation for that cold exposure. This is why, for instance, people that use deliberate cold exposure to try and increase lipolysis, the burning of fat, oftentimes will get results for a while, but then if they're doing it a lot, a lot, they stop getting those effects. I talk a lot about avoiding cold adaptation, if that's your goal, in the episode on cold, but similar mechanisms are at play here. So we have to imagine that when the subjects got into the sauna on day one, whatever pathways went from measurement of temperature at the shell to changes in temperature at the core led to these big increases in growth hormone, which is basically a way of just describing the result I already told you before. But the fact that that result diminished over time either means that the circuit was not as efficient in communicating that shift in temperature or that that shift in temperature was of less impact because the downstream effectors were not engaged to the same extent because it wasn't as much of a shock. And I think the latter explanation is far more likely. This is very much akin to weight training or cardiovascular exercise, where if you run up a hill very fast, for instance, and

your lungs are burning and you're heaving and breathing hard, on the first day, that's a very painful thing. But if you do it every day or every other day, provided you allow yourself to recover, pretty soon you're running up that hill and you're not breathing as hard. There isn't as much burning in your muscles, et cetera, et cetera. Your body adapts. So, one of the key things to understand about the use of deliberate heat exposure is if you're going to use it in order to try and trigger massive increases in growth hormone, you're going to need to be careful about not doing it more than, let's say, once a week. Now, I'm extrapolating from this study. Maybe once every 10 days would be even better, but if you start getting heat adapted, it's very unlikely that you're going to get these massive increases in growth hormone. So I don't mean to be discouraging of using deliberate heat exposure to access growth hormone increases, but if that's your specific goal or your main goal, then I think it's reasonable to say that you don't want to do deliberate heat exposure, at least not of the sort that I described here, more than once a week, or maybe even once every 10 days, and that you would want to time that to other events in your life, maybe hard workouts, or if you are trying to push through a fat loss barrier or simply in order to access growth hormone at peak levels, maybe three times per month or four times per month. If you start doing deliberate heat exposure more often, you'll still get increases in growth hormone, but they are not going to be nearly as large as the increases in growth hormone

01:04:32 Parameters for Heat & Cold Exposure

that you're going to experience if you shock your system with deliberate heat exposure every once in a while. An important way to frame this is actually in the context of cold. And while you might say, wait, this is an episode on heat and heating, not cold, you really can't have a conversation about heat and heating without talking about cold. Because, as I mentioned earlier, if you cool the outside of your body, the shell, you're actually heating up your body. In fact, the circuits that control heating of the body and that control cooling of the body, for instance, the activation of things like shiver or fat loss in response to cold and shiver, those are also controlled by the preoptic area of the hypothalamus. So we can take a step back and start to think about what it would take to design the optimal protocol for deliberate heat exposure by looking at cold, and here's what I mean. There have been beautiful studies showing that if people get into a very cold body of water, four degrees Celsius for 20 seconds. As I mentioned earlier, that will

cause the a 200 to 300% increase in norepinephrine. Norepinephrine is also called noradrenaline. And norepinephrine and other so-called catacholamines like dopamine increased dramatically in this very brief cold water exposure. And those increases in norepinephrine and dopamine are known to have long-lasting effects that generally lead to improvements in mood, focus, and alertness. So they're pretty significant. However, they aren't significant enough to increase metabolism to a very high degree. Whereas, other studies have shown that if people go outside in 16 degree Celsius weather with a proper amount, but a fairly minimum amount of clothing, you can experience even greater increases in norepinephrine. But the time that's required in order to experience those increases is six hours at, for instance, 16 degrees Celsius. So if you have six hours a day to be out there in the cold, or if you can turn the air conditioning on in an environment and make it very, very cold, fine. But basically what I'm describing is that you can sort of bookend the parameters that you can use. You can use a very brief exposure to cold or to heat in order to stimulate heat shock proteins, growth hormone, et cetera, or you can use longer exposure in less intense versions of heat and cold. You really have to find what's going to work for you and what you can do safely. And if you're confused about where to start, please use the parameters that I described earlier. First of all, check with your doctor. As always, make sure that you're somebody who can do deliberate cold or heat exposure safely, but that 80 to 100 degrees Celsius, meaning 176 degrees Fahrenheit to 212 degrees Fahrenheit, that I keep repeating over and over, 'cause I know somebody's going to ask, even though I repeat it over and over, which is fine, I'm delighted to keep saying it, and to respond if someone asks again. Well, those parameters are going to kind of bookend what you should do in terms of the intensity of the heat stimulus. How long? Well, we heard earlier, five to 20 minutes. Why not start with five and then ramp it up to 10 or 15? And then if you're feeling really bold and you really want to crank out growth hormone, well, then you could do that 30 minute four times in one day stimulus every once in a while. So you have to really figure out what you're using heat exposure for. This is one of the reasons why when people say, is it better to get in a wet sauna or dry sauna? What's the optimal temperature? Is it better to take a hot shower or a hot bath or a hot tub? To be completely honest, it depends on what you're going to be able to do regularly, whether or not you want to do it regularly, and what your specific goals are. So the purpose of this episode is really to arm you with the underlying mechanisms and to arm you with the general parameters that are going to allow you to access the results that you're seeking. For what it's worth, I personally

use a protocol, and I've been using a protocol for a long time, that involves trying, meaning I accomplish this most weeks, not all, trying to get into a sauna for three 20-minute sessions every week. I use a dry sauna, so it's not a steam room. If I don't have access to it, I might take a hot bath or something of that sort. But in general, I just stick to doing the sauna three times a week.

01:08:26 Circadian Rhythm & Body Temperature, Cold & Heat Exposure

And I generally will do that either after a workout, either a cardiovascular workout or a weight workout, or I will do it later in the evening. Why later in the evening? Well, it has to do with the circadian shifts in temperature that we all experience. Talked a lot about this in the circadian episodes and the episodes related to sleep. But in a nutshell, here's how it works. Every early morning, about two hours before your typical wake up time, your body temperature is at its all-time lowest. We call that your temperature minimum. Right about waking your body temperature increases. In fact, an increase in body temperature is part of the reason you wake up at all, unless, of course, you're setting an alarm. Increases in body temperature are going to be one of the major things that wakes up your brain and body. Body temperature will tend to continue to increase through the morning. You'll get that increase in cortisol. That's a healthy increase in cortisol. Body tempera will increase into the afternoon, and then we'll start to drop in the later afternoon. This general contour can be shifted by whether or not you exercise, how often you eat, because of the so-called thermogenetic effects of food. That is, every time you eat there's a slight increase in body temperature and metabolism, but it's not really that significant to throw off this general contour and rhythm, but toward the afternoon around four or five o'clock, most days, depending on time of year, your body temperature will peak, and then it will start to drop. And as your body temperature drops by one to three degrees, and here I'm referring to your core body temperature, not your shell body temperature, you will start to get sleepy and to transition into sleep and to maintain sleep throughout the night. Your body temperature will remain low until you hit that temperature minimum, and then it'll start to come up again. What that means is that when you decide to do sauna, or cold exposure for that matter, it's going to be important. Why? Well, as I mentioned earlier, if you were to make the surface of your body cold, at least in the immediate period after that, your body temperature will increase. So for those of you that are challenged in getting to sleep and are still working on your sleep,

remember sleep is the foundation of all mental and physical health and optimal performance, you should try to get really quality sleep of sufficient duration, at least 80% of nights. That should be an ongoing goal throughout your lifespan for a huge number of reasons. Watch the master sleep episode if you'd like to hear are more of those reasons and the mechanisms to make sure that you do that. But in any event, cold exposure late in the evening will start to increase your body temperature again. And that can make it hard for some people to fall asleep. Now, if you're very, very tired, because you've been working hard or training hard or both throughout the day, might not throw off your sleep so much. I've gone through bouts where I'm just so, so busy from morning till night, that the only time I can get into the ice bath or the cold shower is late in the evening and I have no trouble sleeping after that. However, if you have trouble sleeping, I would recommend doing the cold exposure early in the day to match that natural heating, that natural increase in body temperature that occurs across the 24-hour so-called circadian rhythm. Similarly, if you're going to use deliberate heat exposure, you'd be wise to do that later in the day. You'd be wise to do it later in the day because when you get into a warm environment, sure, the surface of your body, the shell, heats up, the core of your body heats up, but then it also activates cooling mechanisms through the preoptic area, and when you get out of that hot environment, sauna or otherwise, your body will continue to cool down. And so many people find that if they do sauna in the later half of the day, or even just before sleep and then take a warmish shower afterwards, then they find it easier to fall asleep.

01:12:00 Heat Exposure & Growth Hormone

And that makes sense because their body temperature is dropping. And in fact, if your goal is to really promote the maximum amount of growth hormone release, that's also going to be the best time of day to do it, especially if you haven't eaten in the two hours before sleep. So if you're really going for growth hormone release, you're really trying to optimize sleep, and the two things are actually linked because of the release of growth hormone that happens from the pituitary in the early nights sleep, well, then you would be wise to do your sauna maybe once or maybe twice a week in the evening or at nighttime, then taking a warm or cool shower just briefly, just enough to kind of rinse off all the sweat from the sauna, and then get ready for sleep. And to do that, not necessarily fasted, but to try and keep your levels of glucose and insulin somewhat low

in your bloodstream. The reason I say that is that having elevated blood glucose and or insulin tends to blunt or reduce growth hormone release, and that's true for any number of different stimuli including exercise and including sauna. So there's a really nice study on this that I can point you to, is this study that was published in the journal Stress. Literally, that's the name of the journal. I love it when journals have these names like Pain or Stress. I find that somewhat amusing for reasons that escape me, but nonetheless, amuse me. The title of this study is "Growth Hormone Response "to Different Consecutive Stress Stimuli in Healthy Men. "Is There Any Difference?" And I don't want to go into all the details of the study, because it's pretty extensive and complicated, but basically what they did is they had people do sauna and then gave them a drug or a condition of having low, not dangerously low, but low blood sugar. Or they had them in a condition where they had low blood sugar and then did sauna. Or they had them do an exercise protocol that led them to increased growth hormone and then had them do low blood sugar. Basically mixing and matching the various stimuli that could increase growth hormone. And what they found was very straightforward. What they found was that doing sauna once and then waiting some period of time and then later that day doing sauna again, they didn't see the same increase in growth hormone both times. First they got a big increase in growth hormone and then less if they did sauna again. If they had people do exercise and then sauna, what they found was exercise could stimulate growth hormone, but then following it with sauna did not allow you to get twice as much growth hormone. In general, anytime you release growth hormone, you reduce the likelihood that you're going to release growth hormone again later that day. And this partially explains that earlier study, where if people did this growth hormone promoting protocol on day one, but then on day three they didn't see quite as big an effect, and on day seven they didn't see quite as big effect. All it basically boils down to is that if you really want to crank out the most amount of growth hormone in response to sauna, do it fasted or at least not having ingested any food in the two or three hours before. You don't have to be deep into a fast, and the whole notion of what breaks a fast is kind of an interesting conversation, because it's contextual. Will a sip of coffee break your fast? Well, maybe probably not. Will one grain of sugar break your fast? No. Will an entire candy bar break your fast? Yes, it has to do with where your blood glucose is when you ingest that particular food item. Not so much what that food item, is per say. But the bottom line here is if you want to crank out the most amount of growth hormone, wait a couple of hours after eating before getting into the sauna, or

maybe do it before dinner and then prepare dinner... Do the sauna before dinner, that is, then prepare dinner, then eat dinner, and then make sure that you wait a few hours before going to sleep. You're going to have to arrange your schedule accordingly. I know most people can't arrange their schedule perfectly just to get growth hormone increases, nor do I think people should approach health protocols that way. I think for 90% of people 90% of the time, just getting into the sauna once or twice or three times a week is going to be beneficial for the number of reasons that I described earlier. And you don't want to obsess too much about out the exact conditions you need in order to get the greatest effect out of that sauna treatment. These are just some additional tweaks related to food intake and low level hypoglycemia and exercise, that if you wanted to leverage, you could. So if decreases in body temperature tend to aid the transition of sleep and getting out of a hot sauna tends to promote decreases in body, it makes sense why you would want to put

01:16:20 Tool: Hydration & Sauna

your sauna exposure or other deliberate heat exposure in the second half of your day, and maybe even right before sleep. Now, regardless of what time of day you do sauna or how frequently you do it, you're going to want to hydrate after going in the sauna. When you go in the sauna, you lose water, and when you lose water, you need to replace it. Why? Well, you need water for all your cells, but you also need electrolytes. So make sure that you're replacing the water that you lose in the sauna. Now there's no exact formula of how much water to drink and whether or not you need electrolytes in that water or not. It's going to depend on how much you sweat, meaning how heat adapted you are. It's going to depend on how much salt you tend to excrete in your sweat. Huge amount of variation, but in general, one way to approach this would be to make sure that you drink at least 16 ounces of water for every 10 minutes that you happen to be in the sauna.

01:17:10 Heat, Endorphins & Dynorphins, Mood

You could do that before and during and after, you could do it during and after, or you could do it after. Now, there are other reasons to do deliberate heat exposure that have nothing to do with cardiovascular effects, nothing to do with growth hormone or anything

of that sort, but rather have to do with improvements in mood and mental health. In fact, the data related to sauna and other forms of deliberate heat exposure improving mood are very impressive, both at the mechanistic level and in terms of the longterm consequences that people experience. First of all, we need to ask, how is it that deliberate heat exposure can improve our mood and wellbeing? Well, it turns out that it improves mood and wellbeing, but it also improves our capacity to feel good in response to things that would ordinarily make us feel somewhat good. Now, this is not a situation where you're going to be walking around grinning ear to ear in response to nothing at all, simply because you went in a sauna. What I'm talking about is the up regulation of pathways, meaning chemical pathways in your brain and body that allow you to experience pleasure in all its fullness. So here's how this whole deliberate heat exposure, sauna, mood thing works. Many of you have probably heard of endorphins. Endorphins are a category of molecules that are made naturally in your brain and body and that are released in response to different forms of stressors. That's right, in response to stressors. So, if ever you've gone out on a long run, and at some point in that run, you feel like you're aching and your joints hurt, or maybe you have shin splints, and you push through that, part of the reason that you experience a lack of pain at some point, usually, or you experience a euphoria during or after that exercise is the exercise-induced effects on endorphin release. Or rather, to be more specific, I should say the exercise-induced consequences on the stress system, which in turn trigger the release of endorphin. In other words, when we experience short term or acute stress, the endorphin system is activated. Now the endorphin system is not just about feeling good, believe it or not. It also about feeling bad. And there are two general categories of endorphins. The first are the ones that you normally hear about, endorphins, things that bind for instance to receptors like the mu opioid receptor. Opioids are not just prescribed compounds or unfortunately drugs of abuse, which they are. We have this opioid crisis in the United States and elsewhere, which is a very serious and tragic thing, but we make endogenous opioids. We make endorphins that naturally act as pain relievers and that make us feel mildly euphoric. We also make endorphins such as dynorphine, that's D-Y-N-O-R-P-H-I-N-E, dynorphine, that actually make us feel worse in response to stressors. When we get into a hot sauna, or a hot environment of any kind, dynorphins are liberated in the brain and body. And I should mention that dynorphins are made by many neurons in many different areas of the brain. So you might think, well, why would I want that? Why would I want to release dynorphine into my brain and body? Well, first of all,

when you get into an uncomfortably hot situation, uncomfortably hot scenario, oh gosh, this is sounding terrible. And a deliberately hot environment that you are using to try and trigger some sort of biological or psychological benefit, I should say, the discomfort that you feel, the desire to get out of that environment, is in part the consequence of the release of dynorphine. It's also the consequence of the activation of that sympathetic nervous system. Remember, the preoptic area can communicate with the amygdala and trigger that kind of fight or flight mode, I want to get out of the sauna. This is really, really hot. But dynorphine is also liberated from a certain number of neurons. Dynorphine binds to what's called the CAPA receptor. The CAPA receptor binds dynorphine and triggers pathways in the brain and body that lead to agitation, to stress, and believe it or not to a general sense of pain. This is why you want to get out of the hot sauna, and remember if it's unsafe levels of hot, then you should get out of that sauna or other hot environment. But if you're working in a range or you're exposing yourself to a range of heat that's uncomfortable, but safe to be in, dynorphine will be liberated from these neurons, bind to the CAPA receptor. And as a downstream consequence of that, there will be an increase in the receptors that bind the other endorphins, the endorphins that make you feel soothed, that make you feel happy, and that make you feel mild euphoria. So there've been a number of studies showing that initially deliberate heat exposure, by sauna or otherwise, causes the release of dynorphine. In fact, I think it's fair to say that every time we get into a hot environment that's uncomfortable or a cold environment that's uncomfortable, dynorphine is likely released and binding to the CAPA receptor. But over time that binding of dynorphine into the CAPA receptor leads to downstream changes in the way that the feel good endorphins, things like endorphin binding to the mu opioid receptor, and there are still other feel good endorphins, so to speak. That system becomes much more efficient, such that people feel an elevation in their baseline level of mood, and when a good or happy event comes along, they feel a heightened level of happiness or joy or awe or improved mood in response to that. This is not unlike the effects of caffeine on the dopamine receptor that I've described previously. And for those of you that aren't familiar with it, many of you drink caffeine and love it. Part of the reason you love it is because of the release of certain neurochemicals, like norepinephrine, et cetera, the energy that it gives you. Maybe the taste, I would hope, as well, but caffeine ingestion also causes increases in dopamine receptor concentration and efficacy. In other words, it allows the receptors for dopamine to work better so that for a given amount of dopamine release, you experience more pleasure and motivation.

This is a similar mechanism, but within the endorphin pathway. So what does it mean? It means that a little bit of discomfort as a consequence of deliberate heat exposure, while in the short term, doesn't feel good, by definition, it is activating pathways that are allowing the feel molecules and neural circuitries that exist in your brain and body to increase their efficiency, placing you in a better position to be joyful in response to the events of life. I confess I'm very excited about the data on deliberate heat exposure and improvements in the chemical systems that underlie good mood. And just to underscore this further, the dynorphine system is not unique to heat-induced stress. In fact, there are beautiful studies and reviews out there about the role of dynorphine in stress and depression, in stress and alcoholism, just as a brief aside, and in the future we will do a whole episode on alcohol and alcoholism, but turns out that chronic alcohol use and alcoholism causes changes in dopamine receptors that make it very difficult for people to achieve pleasure through things other than alcohol, and even alcohol. That's kind of the really diabolical nature of addiction, which is the thing that initially brings pleasure, eventually is just required to maintain baseline levels of dopamine. And I've talked before, and Dr. Anna Lembke, when she was a guest on this podcast, talked about the pleasure pain balance that exists within the dopamine system. It is beautifully described in her book "Dopamine Nation," by the way. Excellent book I recommend to all people, addicts or not. Well, in that context of pleasure and pain it's very clear what the pleasure molecule is. It's actually a molecule more related to motivation, and that's dopamine. The pain molecule, however, appears to be dynorphine. And the fact that dynorphine is dysregulated in stress and depression and alcoholism and the relationship between dynorphine and dopamine is something that we should all take very seriously. And for that reason, I'm very excited about the fact that deliberate heat exposure can leverage the dynorphine system in a short term and an acute way that allows mood to improve after the sauna exposure. So, for those of you that don't like heat exposure, keep in mind that a lot of the observed positive effects on our biology relate to metabolism, cardiovascular function, but also mental health. And along those lines, there is a wonderful study, again, published in 2018. I don't know why. I guess 2018 was a big year for deliberate heat exposure studies. The title of this study is "Sauna Bathing "and Risk of Psychotic Disorders." And this was a prospective cohort study. Again, we'll provide a link to this study. It's a really interesting study that explored the relationship between mental health, so people suffering from various forms of psychoses, schizophrenia and other forms of psychoses, and use of sauna. So essentially what this

study did is they looked at a very large number of subjects, more than 2,000 subjects, who had no history of psychotic disorders. They were classified into three groups based on their frequency of sauna use, either once a week, two to three to times per week, or four to seven times per week. This should call to mind that earlier study on all-risk mortality and cardiovascular event risk. And then they explored the hazard ratio for psychosis specifically, meaning how likely it was that people would develop psychotic symptoms or full blown psychotic illness, according to their frequency of sauna session. So, again, this isn't causal, this is correlative. And according to the data in this study, what they concluded is that there was a strong and inverse independent association between frequent sauna bathing and the future risk of psychotic disorders in this population. Now, this does not mean that going into a sauna seven times per week is going to prevent people from becoming schizophrenic, necessarily, or from having a psychotic episode, necessarily. And of course, frequent sauna use will be related to other health-promoting activities. But in this study, as in the previous study, they went to great lengths in order to try and limit those so-called confounding variables. Now, of course, this is just one study, and again, it's correlative, not causal, but based on the large number of subjects they included, plus the rigor of the statistical analysis, we're starting to see a general picture that using the sorts of sauna protocols that I've described throughout this episode, five to 20 minutes or so, done one to seven times per week is associated with a general improvement in cardiovascular health, a general improvement in mental health, and it really points to the fact that, yes, sauna done acutely for three or four times a day, 30 minutes each session separated by cooling, maybe getting into cold bath, sure that can potently increase growth hormone, but done on a more regular basis can reduce cortisol, improve heart health, improve mental health. And for that reason, and the fact that for most people, it is conceivable to come up with a way that you could get into deliberate heat exposure for a minimum of cost. If it's a hot bath, or if you had to resort to bundling up and going for a jog, this sort of thing, or if you have access to it, a sauna of some sort, that we're really talking about a stimulus to initiate a large number of different biological cascades

01:28:44 Tool: Glabrous Skin To Heat or Cool

that wick out to improve multiple aspects of brain and body health. So up until now, I've been talking about whole body heating. So for instance, putting your whole body into the

sauna, which of course is what most people do, or getting into a hot tub or hot bath up to your neck, or in the cases where we were talking about deliberate cold exposure as a means to increase core body temperature and metabolism, getting into an ice bath or cold water of some sort up to your neck or into a cold shower, et cetera. Now I'd like to talk about deliberately heating or cooling specific parts of the body, meaning certain surface areas of your body as a means to get effects on those particular areas, as well as at the whole body level. Numerous times throughout this episode, I've talked about the dangers of overheating. So what should you do if you think you or someone else is hyperthermic, is too hot? Well, if you understand just a little bit about the cooling and heating systems of your shell and core, there are some terrific tools that you can use in order to cool off your core quickly. And remember the core consists of the nervous system, the spinal cord, and the viscera, which are really the organs you're trying to protect. So, being able to cool off the core of your body quickly can be very beneficial, and in some cases, it could even save your life. There is a way to more quickly heat or cool the body, and that's through specific elements of your shell, meaning particular skin surfaces. I've talked extensively about this in the episode on cold. It was also covered in the episode with my guest, Dr. Craig Heller, from the Biology Department at Stanford. It relates to the so-called glabrous skin surfaces on the upper half of our face, palms of our hands, and the bottoms of our feet. And for those of you that have heard this before I encourage you to continue to listen nonetheless, because today I'm going to talk about specifically how to heat the body or cool the body through these glabrous skin surfaces. Very briefly, the mechanism is as follows. The palms of our hands, the bottoms of our feet, and the upper half of our face overly specific types of vasculature, meaning specific types of veins and arteries that don't have capillaries between them, and as a consequence, heat and cold can move very quickly from the palms of the hands, the bottoms of the feet, and the upper half of our face, and change our core body temperature. There's a name for these particular vascular structures. They're called AVAs or arteriovenous astemoses. Basically veins and arteries interacting directly without capillaries in between, which allows cooling of blood or heating of blood much more quickly than is possible by applying colder heat elsewhere on the body, where capillaries intervene between veins and arteries. These AVAs, arteriovenous anastomoses, can be leveraged to cool off your core body temperature very quickly. The key thing is to get the palms of your hands, the bottoms of your feet, and the upper half of your face in contact with a cold surface or fluid that is cold enough to cool the blood

and the core of your body, but not so cold that it constricts the veins just below the palms of your hands, the bottoms of your feet, or the upper half of your face. So, not placing ice packs necessarily, but maybe placing cool towels on the bottoms of feet, the palms of the hands, and the upper half of the face, and as they warm up, replacing those with other cool towels. The exact temperature will depend on how hot you happen to be. I can't know that without knowing your particular circumstances. If you'd like to learn more about how to cool off your core very quickly, and some of the details and some of the technologies that are being developed to do that, please see the episode I did with Craig Heller or the episode on cold. If you don't want to go to those episodes, here is a good procedure that you could use. You could grab, for instance, a package of frozen broccoli or frozen blueberries. If someone is really, really warm, make sure they take off their shoes and socks, get their feet on top of those. Ideally get some into their hands as well. Get some cool compresses and get them onto people's face. You could, of course, also put a cool compress on the back of the neck, on the top of the head. That would be an especially good idea if someone were hyperthermic because of the way that cooling of the brain occurs under conditions of hyperthermia. But the key point here is that just putting cold compresses or cold materials onto somebody's torso is not going to be as efficient as cooling those glabrous skin surfaces, the bottoms of the feet, the palms of the hands, and the upper half of their face. Similarly, or I suppose to be more accurate, I should say, conversely, there are times when it is desirable to heat the core of the body. And once again, just simply throwing a hot towel over somebody is not going to be the most efficient way. If someone is hypothermic, they're too cold, it is not a problem to cover them with a blanket. But ideally what you do is you use some warm object or warm fluid to warm the bottoms of their feet, their hands, and the upper half of their face. Of course not so warm that you burn those skin surfaces. This has actually been examined in studies from the Heller Lab. Turns out that, for instance, to get people out of anesthesia, it is beneficial to warm their core body temperature. And of course there is fever, which you should know is an adaptive response. While fever is uncomfortable, and in fact often involves a mismatch between our perception of our shell and a perception of our core temperature. In other words, there are times when our body temperature is really high, we have a fever, and yet we're shivering and we're cold. And that's because under conditions of fever, the immune system liberates certain molecules that impact, and in some ways, intentionally disrupt the preoptic area, the POA, and the way it normally functions so that it can override peripheral signals and simply try and

heat the body and kill whatever pathogen has infected the body. So for those of you that think about fever as always a bad thing, it's not. Now, of course we don't want our core body temperature to go so high that tissues of the brain and body are damage. This is one reason why, if a fever ever goes above 103, you need to start getting a little bit worried, 104. There are times when you need to call an ambulance or go to a hospital, you really need to employ cooling methods of the sort that I talked about before to prevent hyperthermia. Of course, safe ranges for body temperature vary between infants and adults. So you can look those up online, depending on the person's age, what is a safe range, what is not. But keep in mind that if you are taking compounds, pills to reduce your fever, you are actually short circuiting the protective mechanism for burning up the pathogen. And that's because most pathogens, bacteria and virus, don't survive well at high temperatures. In fact, in laboratories, if we want to preserve a virus for use, we put it into a freezer. If we want to kill a virus, we heat inoculate it. So in many ways, fever is your natural form

01:35:33 Local Hyperthermia, Converting White Fat to Beige Fat, Metabolism

of heat inoculation designed to kill pathogens of various kinds. Now last, but certainly not least, I want to refer to the study that I described at the very beginning of this episode, involving what's called local hyperthermia in order to trigger a number of biological processes in fat tissue in order to convert white fat to beige fat, which is the metabolically active form of fat. Many of you, or at least some of you, should be familiar with the fact that deliberate cold exposure can increase brown fat stores, these mitochondrial dense fat stores that can, in turn, allow a person to feel more comfortable in cold temperatures, water, or otherwise, and increase core metabolism. I talked about this in the episode on cold, but very briefly, the general protocol, again, is to get 11 minutes total per week of uncomfortable, yet safe deliberate cold exposure, either through ice bath, cold shower, cold immersion up to the neck, or some other form of cold exposure. That triggers increases in brown fat. That's been beautifully shown by Dr. Susanna Søberg. And that increase in brown fat in turn increases core metabolism and one's ability to feel comfortable in cool temperatures. This was a study done in humans, and there's now ample evidence from animal models to support that this is a general phenomenon that I think most people could use and benefit from. Local hyperthermia is a distinctly different phenomenon. It involves heating a particular surface of the body as

a way to convert the white fat at that location to beige fat, which in turn leads to more systemic increases in thermogenesis and increases in metabolism, and believe it or not, in fat loss. Now, the study that I'm referring to is a very recent study that was published, again, in this terrific apex journal, Cell, Cell Press Journal. And again, one of the three top journals, Nature, Science, and Cell are the three top journals. Top because they're the most competitive, but also generally, not always, but generally the most stringent in terms of the review process. Papers that make it into these three journals generally are of very, very high quality. And certainly enough people see them that if they're not of high quality, they get shot down pretty quickly in a short amount of time. Whereas papers in other journals can sometimes last a long time before they're ever replicated, et cetera. The title of this paper is "Local Hyperthermia Therapy Induces Browning of White Fat "and Treats Obesity." This was a study that was performed on mice and humans in the same study. What this study involved was heating of a local patch of skin to 41 degrees Celsius, which is a 105.8 degrees Fahrenheit, but not damaging the skin. So the methods of heating did not involve placing something on the skin that would damage it. In fact, in the study on the mice, they used this kind of clever molecular chicanery in order to do it. And in humans, they used a thermocouple that would allow them to heat the skin up just locally in particular locations on the body that I'll talk about in a moment. They refer to this process as LHT, or local heat therapy. The reason they did this is worth considering. It's long been known from clinical data. And in fact, from a bit of research data that people that experience burn on a small, or unfortunately in some circumstances, significant portion of their body experience overall decreases in body fat and increases in metabolism that can last many years, Now, of course, is not reasonable nor would one ever want to induce burn in order to induce fat loss. But the observed increases in metabolism and fat loss in response to skin surface burn couldn't be explained by reductions in activity related to the burn, for instance. And in fact, there are molecular pathways related to something called UCP1, which is uncoupling protein one. I talked about this also in the cold episode, but don't worry if you didn't see that episode, or if you choose not to. UCP1 has the ability to increase mitochondrial function in ways that increase core body temperature overall, in particular, in beige and brown fat, which are these fat cells that exist generally along our spine, and in particular, in the upper part of our back and around our neck and clavicles. And they're responsible for acting as this sort of a candle, or I should say the fuel or the fat of a candle that can be burned up to manufacture heat in the body. So, if you normally think about fat and you think about

blubbery fat, you're thinking about white fat, which again is just a storage site. Beige fat and brown fat exist at just a few locations, mainly internally, around our spinal cord and our clavicles, and those fat stores are responsible for generating heat in our body. So they're a very metabolically active form of fat. Small children have a lot of brown fat and beige fat, in particular because very young children can't shiver. A number of you probably didn't know that, but very young children can't shiver, so they need some way to generate heat in order to make sure that they stay alive if they were ever to get cold. This is also probably the reason why little kids can run around on a cold day outside without their shirt on and they don't even seem to notice, whereas adults are freezing cold. As we get older, the amount of beige and brown fat tends to either reduce or shrink or disappear entirely. It's still debated which happens. But we know that white fat can be converted to this more metabolically active form of beige fat by deliberate cold exposure, according to the protocol I talked about earlier, and now it seems, based on this new study, that local heating of skin tissue can also induce UCP1 and the effects of UCP1 on increasing mitochondria. And in fact, that local hyperthermia, 41 degrees Celsius, that is 105.8 degrees Fahrenheit, can actually induce the conversion of white fat to beige fat. Now that's pretty interesting, and I can already predict the way this is probably going to go in the kind of wellness and biohacking and longevity communities. I'm sure that pretty soon there are going to be people putting heating pads on different fat pads of theirs on their body, trying to reduce, or at least convert the white fat into beige fat. And who knows, maybe that'll work. There have not been many controlled studies of this yet. This is the first, at least to my knowledge, of such studies looking at this in non-burn conditions. Nonetheless, the data are mechanistically even more interesting than this whole business about UCP1, and here's why. Local hyperthermia, using the protocol that I described before, resulted in the increase of a promoter, which is essentially a mechanism by which certain genes regulate their activity. This is a DNA binding of something called HSF1. We don't have to go too deep into the mechanism here or the nomenclature, but HSF stands for heat shock factor one. And HSF1 binding to a particular location in the genome allowed for a different molecule with a very long name. I'll just tell it to you for fun, but you can just let the numbers and letters stream by. It's not important. HNRNPA2B1, shortened to A2B1, which frankly is not that short to begin with, A2B1, is still a name that should be meaningless to most everybody, but here's what's really cool. A2B1 is directly involved in glucose and lipid metabolism and regulates the genes that control glucose and lipid metabolism. So here we have a situation where

local heating of skin converted a metabolically sluggish or inactive cell type, the white fat cell, into the metabolically charging, so to speak, beige fat cell, which in turn led to systemic, meaning body-wide increases in metabolism, through two mechanism. One mechanism is this increase in UCP1, which for those of you that want to know, UCP1 causes shifts in the way that potential energy is pushed from the protons through the mitochondria, basically more mitochondrial function, which means more ATP, which means cells are more active, AKA, increased metabolism, and increases in things like heat shock factor one and A2B1, which are involved in lipid and glucose metabolism and regulation. So I want to be very clear, this study does not say that spot reduction is possible with local heating of tissue. I just can see it now that once this paper gets out into the press, people are going to say, oh, heating up a certain patch of skin is going to burn fat or convert fat to some other cell type at that location. Sorry, that's not the way it works. They did observe increases in beige fat cells at certain locations in the body. But those increases in beige fat occurred where beige fat cells always reside, around the spine, the upper neck, the clavicles, and so on. This is exciting because it provides yet another potential mechanism in addition to deliberate cold exposure to increase beige fat, meaning the metabolically active form of fat cell. It also nicely provides a mechanism, or at least a potential mechanism, for the observation that burn, either small patch of skin being burned, or again, sadly large patches of skin being burned, leading to these very extreme and very long lasting increases in body fat loss and metabolism. What, if anything, should you do with this information? Well, first of all, I want to very much caution people about putting anything so hot that it can damage the surface of your skin onto your skin. That would be a terrible idea. However, I do predict a time not too far from now where people will start to explore the use of local skin heating as a means to increase the conversion of white to beige fat, and in turn for beige fat stores to increase metabolism overall, and maybe even improve glucose metabolism and thermogenesis. If you'd like more detail else about this study, we will provide a link to it in the show notes caption. I should mention that the study, at least the portion of the study that was focused on humans, involved roughly equal numbers of males and females. The subjects followed their normal daily schedule, including time and composition of meals, they say, rest and active hours, et cetera, et cetera. The local hyperthermia therapy was done in the following way. Here I'm paraphrasing from their methods section. Subjects were seated in an upright posture. They were wearing a standard test robe with the head and neck and shoulders unclothed and one meter away

from a thermal imaging camera, which could basically measure the temperature at their skin surface to make sure that it remained constant across subjects and yet safe. The supraclavicular fat deposits, meaning the upper shoulders and upper back area, were exposed to this thermal source, again, 41 degrees for 20 minutes. So it was 41 degrees for 20 minutes. And their core temperatures and skin temperatures were monitored before and after this local hyperthermic therapy. The subjects were exposed to this local hyperthermia therapy three days per week, separated by day, Monday, Wednesday, and Friday, so they had weekends off, for five weeks total, after which their data were collected. And the study has a number of other really interesting features that are sure to lead to increased understanding of both mechanism and new protocols,

01:47:00 Hormesis/Mitohormesis & Heat/Cold Exposure

such as analysis of the genes and proteins that are activated downstream of this local hyperthermia therapy. I find these data incredibly interesting, in part because of the ways that local hyperthermia therapy mimics deliberate cold exposure therapy. Same downstream mechanisms, UCP1, and some of the other pathways are involved, and all of that points to a somewhat new, but certainly an important concept. Many of you have probably heard of hormesis, which is the subjecting of one's self, or others, I suppose, to enough stress to induce an adaptation of some kind. So hormesis is the reason why if you get into cold water repeatedly, at first, it's very painful psychologically, and over time you get used to it. You never get completely used to it, but you get more used to it. Hormesis is also used to describe the adaptation to cardiovascular exercise or to the hard rep sets of resistance training and the growth of muscles or the strengthening of muscles or the improvement in cardiovascular function to endurance exercise and so forth. Hormesis is a somewhat common term nowadays. If you haven't heard it, now you've heard it. In this paper they describe what is called mitohormesis, which is, in essence, the fact that any number of different stressful stimuli, provided they activate UCP1 and some of these other pathways that I just described, like HSF1, can induce changes in the mitochondria that lead to increases in metabolism. So it shouldn't surprise us that cold and heat can both lead to increases in metabolism and conversion of white fat to beige fat. It shouldn't surprise us because both pathways are stress. Local hyperthermia is stress. Burn certainly is stress. Sauna is a form of stress. Deliberate cold exposure is a form of stress. Exercise is a form of stress. And the adaptation to those

stressors is not infinite. All of those protocols, any protocol for that matter, is going to be effective because it's going to converge on an existing internal biological mechanism. So there's no unique mechanism for each protocol. Each protocol that I've talked about today, whether or not it's five minutes or 20 minutes or four times in a day or three times per week or seven times per week is tickling or pushing or stomping, if you will,

01:49:11 Benefits of Heat Exposure

on a given pathway and really activating it to a mild or to a severe degree. What I've tried to do is to illustrate the general mechanisms by which heat in particular can activate certain biological pathways so that you can devise protocols that are going to be optimal for you and your needs. So just to briefly recap, if you want to get the greatest growth hormone increases, do sauna or other deliberate heat exposure fairly seldom, probably no more than once per week, maybe even less, and do it a lot that day. Just make sure that you break it up into multiple sessions. In the study I described earlier they did four sessions, 30 minutes each. But that was just once a week. If you're interested in the cardiovascular benefits and the potential longevity benefits of sauna, well then it's clear that doing it three to four, maybe even seven times per week is going to be more beneficial than doing it just one or three times per week. It stands to reason that for those of you interested in the general health effects of sauna, about an hour per week broken up into three sessions makes the most sense based on my read of the data. And again, that range of 80 to 100 degrees Celsius is going to be your guide. And in terms of the mental health benefits, it seems that getting a little bit uncomfortable in that heat environment, sauna or otherwise, provided it's safe, is going to be the best way to access those mental health effects by way of increasing dynorphine, which, as you recall, will then increase the ability of endorphin to have its positive effects on mood after you get out of the sauna or other deliberate heat exposure. And in terms of timing, after a workout of any kind, morning or afternoon, or if you're not doing it after a workout, certainly in the later part of the day is going to be most beneficial as it relates to sleep. But of course, there's a caveat there, which I will mention again, which is that for those of you that have no trouble sleeping 'cause you're exhausted or you're just one of these phenomenal sleepers, well then do it any time of day or night. But for most people doing it later in the day is going to be more beneficial

01:51:10 Zero-Cost Support, YouTube Feedback, Spotify & Apple Reviews, Sponsors, Momentous Supplements, Instagram, Twitter, Neural Network Newsletter

because of the post sauna cooling effect and the relationship between cooling by a degree or more as a way to enter sleep. Thank you for joining me today for my discussion about the science of heat and heating for health. If you are learning from and or enjoying this podcast, please subscribe to us on YouTube. 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. If you have comments or feedback or suggestions about topics or guests that you'd like us to cover on the Huberman Lab Podcast, please put those in the comment section on YouTube. We do read all the comments. Please also check out the sponsors mentioned at the beginning of today's episode. That is the best way to support this podcast. As also mentioned at the beginning of the episode, we are now partnered with Momentous Supplements. So if you go to livemomentus.com/huberman, you'll find what we firmly believe to be the highest quality supplements available in the specific dosages that match the peer reviewed science and recommendations made on various episodes of the Huberman Lab Podcast. You will also find specific protocols of how much to take and when, what time of day, what time of night, et cetera. And you will also find behavioral tools that can synergize with those supplements. Many of you will also be pleased to learn that Momentous Supplements, of course, ships within the United States, but also internationally. If you're not already following us on Instagram or Twitter, please do so. It's Huberman Lab on both Instagram and Twitter. Both places I talk about science and science related tools in short little snippets that often overlap with the contents of the podcast, but often is distinct from the contents of the podcast. In addition, please consider signing up for our newsletter, the Neural Network Newsletter. You can do that by going to hubermanlab.com. I should point out that we do not share your email with anybody, and we have a very clear privacy policy that is at that location at hubermanlab.com. The Neural Network Newsletter includes protocols and podcast summaries and other things that we believe people will find useful. And last, but certainly not least, thank you for your interest in science.