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 will 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 the body. 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. That's what we typically think of as blueberry fat. Bage 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. 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, it turns 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 emerge 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 obesity and metabolic disorders and that you can apply for basic things like fat loss. I'm pleased to announce that the Hubertman 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 Hubertman Lab podcast. If you go to live momentous.com slash Hubertman, you will see those formulations. I should mention that we are going to add more formulations in the months to come and you will 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 our 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 momentous.com slash Hubertman, 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 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 Hubertman 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 are both available at HubertmanLab.com slash 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. 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. You know, 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 in 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 your 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, etc. 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, 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 that 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. 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. 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. And once you have that in hand, along with the understanding you now have about the fact that you've 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 100 years. In fact, it's kind of amusing to me that nowadays there's a 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 a vital interest to many people in many laboratories, but thermal regulation was considered more, you know, I think 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 and mice and in humans and translates immediately to protocols that anyone can use. Now, a brief warning now and another brief warning later, any time 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 neurons 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. Be smart about it. I don't just say 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 need to memorize one acronym, but it's very easy. It's called the POA. If you remember POA, you'd 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 this circuit because once you understand the 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 are 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 exist at the top part of your spinal cord called the Dorsal Horn. The name again doesn't matter. So here's 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 parabricule area. You don't need to know lateral parabricule area, but it's a relay station. The lateral parabricule area sends electrical signals to the POA. And I would like you to know POA. The POA stands for pre-optic area. Neurons in the pre-optic area basically reside over the roof of your mouth. These are neurons within the hypothalamus. And neurons in the pre-optic 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 pre-optic area receive an electrical signal through the circuit I just described that goes from skin to Dorsal Horn in the spinal cord to lateral parabricule, 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. Even if you don't have a pre-optic area, you can't even see the potential of the brain. If you don't have a pre-optic area, you can't see the potential of the brain and the tissues of your body to get them to die. 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 pre-optic area neurons that send signals out to what's called the periphery of your body and other chemicals are released, like a cedal calling that get you to sweat. If you happen to be shivering, neurons in the pre-optic 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 pre-optic 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 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 this 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 afternoon. So 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. And when 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, right, 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. 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, right. 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 trying 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 are 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. And if 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 the preoptic area can kick off a bunch of autonomic subconscious responses to heat, which make us attempt to get cooler, things like sweating, vasodilation, etc. 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 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. We 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. 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. Now, 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 because I do realize that a lot of people don't have access to sauna. First off, the temperature ranges that were used in this study 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. Now, sweater you wear, but the verb sweater, you get better at sweating, at dumping heat through the loss of water. 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 5 to 20 minutes per session. And as you'll soon learn, very brief periods of just 5 minutes of heat exposure can be a powerful stimulus if the heat exposure is significantly great enough for you. OK, 20 minutes can also be beneficial, but 8,200 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 of 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, eight 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. In fact, the benefits were even greater for people that were 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. 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 smoke, 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 into 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 where 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 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 they 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 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 the 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 is an laboratory study there's there are ways to create a hot environment such that you heat up your shell in your core safely without having to measure your core temperature all along. If you want to do that be my guest 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 in 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's 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 research 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 will 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 rest of the rest of the day. You could actually buy one of these plastic suits they're really called plastics that wrestlers or other athletes that wish to drop water weight will wear and then go jogging that all of those will increase your shell in your core body temperature right especially if you do it on a hot day but of course be careful hydrate and don't over heat don't become excessively hyperthermic because 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 will 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 for very brief sessions. So maybe not a continuous session will 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 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 son is 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 etc 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 right which sauna which stimulus do you run in wearing plastics and a hoodie and we'll have you get into a sauna that's going to depend a lot on your circumstances your budget and what you are doing. 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 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 you can do. You can do that in your brain and body that allow for the various health benefits of sauna or other forms of deliberate heating well we talked about reduce 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 etc I will detail those so what happens when you get into a hot environment what are the mechanisms that allow for the various health effects. Well your shell your skin senses that and through the circuit that I described earlier activates neurons in the POA the preo optic 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 you're going to see the end of the day. And also increases and your heart rate increases to anywhere between a hundred 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 in 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 and bone density etc etc but basically your heart starts beating more blood starts circulating your vascular to change your 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 where you're drinking. 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 the study was in this case just done on men I'll just briefly describe the protocol they use they had these men attend for sauna sessions of 12 minutes each. So again well within that range of 5 to 20 minutes 12 minutes the temperature of those on us 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 D H E A 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 I'm not sure if I'm going to be able to do that. So I'm going to 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 happens early in the day late day increases in cortisol are associated with depression that's been shown by studies that Stanford and elsewhere. And the 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 long term 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 as ashwaganda that can be used to limit cortisol but you have to be careful not to use ashwaganda 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 over stressed there. For one reason or another they're subjected to many too many stress or is or their level of stress resilience isn't high enough to keep their cortisol levels clamped at a healthy level. So the protocol described of 12 minute exposures to 90 degree environment that's again 90 degrees 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 cold shower afterwards that had a very significant effect on lowering cortisol so there you have a tool it's not a completely zero cost tool because you need to heat the water you need to have access to hot and cold water at least hot and cold contrast of the water. And cold contrast of some sort but it's fairly minimal cost it 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 overall. 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 DHA etc using this protocol as you 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 back 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 and the related protocol 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 protein or HSP's 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 are familiar with the fact that 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 its texture right 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 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 serve 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 are 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 some of meaning drosophila fruit flies because they're a 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 to the effect of the heat exposure in this field of deliberate heat exposure as that relates to longevity is that if they expose these flies these fruit flies to 70 minutes of a heat stimulus that what 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. The reason to use model organisms 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 health overall and possibly and I want to highlight possibly possibly extend life. So the one such mechanism involves a genetic program involving a molecule called Fox 03 Fox 03 is a very interesting molecule because it's involved in DNA repair pathways DNA repair is part of the process of remaining healthy you know 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 body. So we have a very simple repair of our proteins and ourselves in a modification of the genes that are being expressed you know puberty being the most dramatic example right you see a kid before puberty and after we look like a different kid sounds like a different kid thinks like a different kid in fact basically is a different human being right 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 in the brain. So our biology is literally the conversion of different brain centers from one function to another. That's puberty 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 life span genes are being turned on genes are being turned off. And DNA the stuff of genes gets damaged in that process. Fox03 sits upstream in a pathway related to DNA repair and again clearing of these sentencing cells. Sonic exposure in particular sonic exposure 2 to 3 times or ideally 4 to 7 times per week in that 80 to 100 degree Celsius range has been shown to upregulate levels of Fox03. So 3 in turn up regulates pathways related to DNA repair and clearing out of the sentencing 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 I 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 Fox03 there are individuals out there that have either additional copies of Fox03 or who have versions of Fox03 that are hyper active 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 Fox03 more clearance of sentencing cells more DNA repair etc. For the rest of us at least to my knowledge I don't have one of these health promoting Fox03 mutations remember mutations can be beneficial or they can be detrimental this if your goal is to live longer is a beneficial mutation. Well if you don't have these Fox03 mutations that allow you to be a centenarian at 2.7 times higher likelihood than other people deliberate heat exposure is one way that you can increase Fox03 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 Fox03 and that's probably because there isn't one. There is no sauna protocol designed specifically to reduce cortisol or specifically to increase Fox03 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 you can see that there is no need to be a lot of time to talk about the same things. So I'm going to start with the question to in terms of deliberate heat exposure and I would encourage you to use that five to 20 minutes per session for the sauna as your rough guide of how long to remain in the 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 soberg 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. 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 most cases so for those of you that are interested in improving metabolism check out the episode on cold or just take the sober 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 the summer of the 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 talked about the use of sauna to increase heat shock proteins we talked about the use of sauna to increase Fox03 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 hormone arrives from neurons that exist in the hypothalamus so growth hormone releasing hormones believe you're 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 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 transfer formations 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 adolescents 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 blood stream this is one of the reasons why many people are drawn to intermittent fasting or even prolong fasting 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 HubertmanLab.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 certain forms of food 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 this 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 four time okay 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 HubertmanLab.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 sonic 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 okay 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 three fold 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 noraponephrine 200% it can double the amount of noraponephrine 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 become cold adapted this circuit that compares the shell in core of your body would adjust in ways that it could either predict that cold stimulus or more likely to create some thermogenic mechanisms in preparation for that cold exposure this is why for instance people that use deliberate cold exposure to try and increase liposis 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 subject got into the song 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 provide you allow yourself to recover pretty soon you're running up that hill and you're not breathing as hard there isn't much burning in your muscles etc etc 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 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're 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 that you're going to experience if you shock your system with deliberate 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 pre-optic 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 you know four degrees Celsius for 20 seconds as I mentioned earlier that will cause a 200 to 300% increase in noripinephrine noripinephrine is also called noradrenaline and noripinephrine and other so-called catecholamines like dopamine increased dramatically in this very brief cold water exposure and those increases in noripinephrine and dopamine are known to have long lasting effects that generally to improvements in mood, focus and alertness 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 degrees Celsius weather with a proper amount but a fairly minimum amount of clothing you can experience even greater increases in noripinephrine 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 make it very very cold fine but basically what I'm describing is that you can sort of book end 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 etc 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 because 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 book end what you should do in terms of the intensity of the heat stimulus how long well we heard earlier 5 to 20 minutes why not start with 5 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 4 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 army with the underlying mechanisms and to army 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 accomplished this most weeks not all trying to get into a sauna for 3 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 3 times a week and I generally will do that either after a workout either cardiovascular workout or a weight workout or I'll 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 2 hours before your typical wake up time your body temperature is at its all time lowest okay we call that your temperature minimum right about waking your body temperature increases in fact an increase in body temperature as 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 in body body temperature will tend to continue to increase through the morning you get that increase in cortisol that's in healthy increase in cortisol body temperature 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 thermogenic effects of food that is every time you eat there's a slight increase in body temperature metabolism it's not really that significant to throw off this general contour and rhythm but toward the afternoon around 4 5 o'clock most days depending on time of here your body temperature will peak and then it will start to drop and as your body temperature drops by 1 to 3 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 they'll start to come up again okay what that means is that when you decide to do sauna or cold exposure for that matter is 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 challenging getting to sleep and are still working on your sleep remember sleep at 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 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 ballots 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 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 hours 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 they do sauna in the later half of the day or even just before sleep and then take a warm warm shower afterwards then they find it easier to fall asleep 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 have an eaten in the two hours before sleep okay 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 night time 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 blood 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 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 increase growth hormone and then have them do low blood sugar basically mixing and matching the various stimuli that could increase growth hormone and what they found was very straight forward 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 and then in general any time 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 people did this growth hormone promoting protocol on day one but then on day three they didn't see quite as big of effect and on day seven they didn't see quite as big of 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 right will a sip of coffee break your fast well maybe probably not will one grain of sugar and break your fast no will a you know 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 se but the bottom line here is if you want to crank out the most amount of growth hormone get weight a couple of hours after eating before getting into the sauna 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 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 can do it for you. So if decreases in body temperature tend to aid the transition to sleep and getting out of a hot sauna tends to promote decreases in body temperature it makes sense why you would want to put 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 it's great in your sweat. So you need a 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. 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 long term consequences that people experience. First of all we need to ask how is it that deliberate heat exposure can improve our mood and well being well it turns out that it improves mood and well being 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 embody 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 embody 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 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's 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 all 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 dinorphin that's dynoorphin that actually make us feel worse in response to stressors. When we get into a hot sauna or a hot environment of any kind, dinorphins are liberated in the brain and body. I should mention that dinorphins are made by many neurons in many different areas of the brain. You might think well why would I want that? Why would I want to release dinorphin 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 dinorphin. 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 dinorphin is also liberated from a certain number of neurons. Dinorphin binds to what's called the capa receptor. The capa receptor binds dinorphin 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, dinorphin 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 have been a number of studies showing that initially deliberate heat exposure by sauna or otherwise causes the release of dinorphin. 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, dinorphin is likely released and bind to the capa receptor. But over time, that binding of dinorphin to the capa receptor leads to downstream changes in the way that the feel good endorphins, things like endorphin binding to the muopiod 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 improve 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 may be 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 good 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 dynorphin system is not unique to heat and do stress. In fact, there are beautiful studies and reviews out there about the role of dynorphin in stress and depression, in stress and alcoholism, just as a brief aside. 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. Analemki, when she was a guest on this podcast, talked about the pleasure, clean balance that exists within the dopamine system. It's 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 dynorphin. And the fact that dynorphin is dysregulated in stress and depression and alcoholism and the relationship between dynorphin 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 dynorphin system in a short term and a cute way that allows mood to improve after the sauna exposure. So 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 2000 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 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. 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, frequency of 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 have described throughout this episode, right, 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 a 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, right? So that'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 that wick out to improve multiple aspects of brain and body health. 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, etc. 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 glamorous skin surfaces on the upper half of our face, palms of our hands and the bottoms of our feet. Those of you that 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 glabber skin surfaces. Very briefly, the mechanism is as follows. The palms of our hands, the palms of our feet and the upper half of our face, overlies 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 palms 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 that are called AVAs or arteriovenous estomoses. Basically, veins and arteries interacting directly without capillaries in between, which allows cooling of blood or heating of blood much more quickly, then as possible by applying colder heat elsewhere on the body, where capillaries intervene between veins and arteries. These AVAs, arteriovenous estomoses, can be leveraged to cool off your core body temperature very quickly. The key thing is to get the palms of your hands, the palms 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, palms of your feet or the upper half of your face. So, not placing ice packs necessarily, but maybe placing cool towels on the palms of your feet, the palms of your hands and the upper half of your 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's 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 out 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 glabber skin surfaces, the palms 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 bottom. To warm the bottom 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. It 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. Well, fever is uncomfortable. In fact, often involves a mismatch between our perception of our shell and 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, 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 to be. So, for those of you that think about fever is 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 damaged. This is one reason why if a fever ever goes above 103, you need to start getting a little bit worried. If you're 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're actually short circuiting the protective mechanism for burning up the pathogen, and that's because most pathogens, bacteria and viruses 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 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 Soberg and that increase in brown fat in turn increases core metabolism and one's ability to feel comfortable in cold 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 a very, very high quality. And certainly enough people see them that if they're not a high quality, they get shot down pretty quickly in a short amount of time, whereas papers and other journals can sometimes last a long time before they're ever replicated, etc. 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 the study involved was heating of a local patch of skin to 41 degrees Celsius, which is 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 cannery 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 as a 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 uncoppling protein 1. 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 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 blueberry fat you're thinking about white fat which again is just a storage site beige fat and brown fat existed 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 very metabolically active form of fat. Small children have a lot of brown fat in beige fat in particular because very young children can't shiver and 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 where as 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 UCP one. And the effects of UCP one 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 they're 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 UCP one 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 HSF one we don't have to go too deep into the mechanism here or the nomenclature but HSF stands for heat shock factor one and HSF one 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 layers 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 the UCP one which for those of you that want to know UCP one 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 increase 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 levels. 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 details 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 meals they say arrest and active hours etc etc. The local hypothermia therapy was done in the following way here I'm paraphrasing from their method section subjects were seated in upright posture they were wearing a standard test robe with the head neck and shoulders unclosed 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 superclavicular fat deposits meaning the upper shoulders and upper back area were exposed to this thermal source again 41 degrees for 20 minutes. So is 41 degrees for 20 minutes and their core temperatures and skin temperatures were monitored before and after this local hypothermic therapy. The subjects were exposed to this local hypothermia therapy three days per week separated by a 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 such as analysis of the genes and proteins that are activated downstream of this local hypothermia therapy. I find these data incredibly interesting in part because of the ways that local hypothermia therapy mimics deliberate cold exposure therapy same downstream mechanisms UCP one 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 oneself 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 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 term during 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 a mitohormesis which is in essence the fact that any number of different stressful stimuli provided they activate UCP one and some of these other pathways that I just described like HSF one 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 base fat. It shouldn't surprise us because both pathways are stress. Local hyperthermia is stress. Burn certainly is stress. Sonsnet 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. 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 on a given pathway and really activating it to a milder to severe degree. What I've tried to do today 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 a 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 really 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's a 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 otherwise provided safe is going to be the best way to access those mental health effects by way of increasing 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 mention again which is that for those of you that no trouble sleeping because 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 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're learning from and are 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 human lab podcast please put those in the comments 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. 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