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 discussing the immune system and we are also discussing the nervous system, which is the brain spinal cord and the connections of the brain and spinal cord with all the organs of the body. We are also going to discuss how the nervous system can be used to activate and control the immune system. About 10-20 years ago, somebody said that the mind could control the immune system, it'd probably get laughed out of most academic conferences and certainly the work wouldn't be published in quality journals. But nowadays, there are dozens, if not hundreds, of quality peer-reviewed studies on how the mind and how the nervous system can control activation of the immune system. This is a wonderful growing body of research and just to give you a hint of where we are headed with this, just this last week, there was a paper published in Nature, which is the Apex Journal for Scientific Publishing, Premier Journal, Extremely Strangent, a paper published in Nature from Chufu Maz Lab at Harvard Medical School, explored how acupuncture can reduce inflammation in the body. And I will describe this study in a bit more detail later, but what they discovered was that by stimulating the body in particular ways, that particular sites on the body, they were able to liberate certain cells and molecules that enhance the function of the immune system, and potentially can be used to combat different types of infection. And just to give you another little hint, they found that a particular type of organ tissue called fascia, some of you may have heard of fascia, fascia, surrounds our muscles, just to look at it, you might think it's a kind of useless tissue, it's sort of like a dense bag in which the muscles are contained. Well, it turns out that those dense bags are much smarter than we thought. They don't have a mind of their own, but by stimulating the fascia in a particular location on the body, there's a pathway leading out of that fascia directly to an organ called the adrenal medulla. I'll explain what all this means, that could liberate particular chemicals that had a potent anti-inflammatory effect. What we're basically saying is that the nervous system acts as a set of highways between the different tissues of your body, calling into action the immune system, liberating particular molecules that can reduce inflammation and lead to faster healing. And I will explain how all of that works, as well as some other non-acupuncture methods for activating and enhancing the function of the immune system. So today we're going to be talking all about healing with the mind in a completely non-mystical, non-abstract sense. 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 the immune system and the nervous system and how the two interact and how you can control your immune system to serve you better. We are going to talk a lot of mechanistic science, a little bit of detail. You're learned some new language around the immune system, names of the different cell types and so forth. But I promise to make it all very clear, regardless of your background. We are also going to discuss a lot of tools. And I think many of you are probably here because you want to know what you can do in order to boost or enhance the function of your immune system. That's a very reasonable question to ask. I want to begin by just acknowledging that if one were to put that question into the internet, you would get back a lot of answers. And there is now a sort of generic form of that answer that deserves our respect, but is not going to be the topic of conversation today. I just want to tip my hat to it. However, and list off a few of the things that we know set us up to be healthier than we would be if we didn't do these things. So the first, of course, is the foundation of all mental and physical health, which is to get adequate sleep, meaning enough sleep, whatever it is for you that you require to get deep sleep. So it's got to be of high quality and to time that sleep correctly, meaning you can't sleep during the day one day and at night the next day and expect your system to function well. Talks a lot about that before on this podcast. You need a relatively consistent sleep schedule, most of the time, about 80% of the time, or even better would be 90% of the time. But the realities of life make it that we can't always go to bed at the same time and wake up at the exact same time. Okay. So we need sleep. We do need sunshine. Why do we need sunshine? Because it sets our rhythm into a regular state where the genes in all of ourselves can be expressed at the correct times. We're sort of a factory of cells, if you will, and that factory can only run properly. If it knows when certain things should be active and when certain cells should not be active, and the best way to coordinate all of those activities of all the cells is to get sunshine in your eyes in the morning and again in the evening and not to get too much bright light in your eyes in the middle of the night. That's just foundational. And then any list that you'll find on any number of websites on the internet would say, okay, get good sleep, get sun, get exercise, how much exercise? We should all be getting 150 to 180 minutes of zone two cardio. That's cardiovascular exercise where we can just barely hold a conversation or maybe not. Per week, we should be eating well. We're always told we have to get good nutrition. What good nutrition means to you is going to be different than what it means to somebody else. But we acknowledge that food intake and quality of food in particular, avoiding processed foods that's going to be important. Social connection is important. Hydration is important. You're starting to get the picture. We can take all that, acknowledge it as useful and foundational for mental and physical health. But of course there are many people who still struggle with getting ill too often or with not being able to heal from physical injuries and wounds or from various bacterial and viral infections quickly enough or deal with chronic disease. And so today is really about how you can take all of that information, acknowledge it and follow it. But in addition to that, there are things that you can do to leverage your nervous system in order to enhance the function of your immune system in very robust ways. So that's where I'd like to shift the conversation to. The first topic we have to attack is the question of what is the immune system and how does it work? I think many of you have heard of antibodies or killer cells or the various organs of the body that are involved in the immune system like the bone marrow, the spleen, the thymus and the lymph nodes. I'd like to just take a moment and do a sort of brief immune system 101. Really simple. Cover the basic elements of the immune system so that everyone listening or watching this can get a clear sense of how the immune system function and what it's basic. Parts are for some of you this might be too basic. It might be a little bit of background that you already know. I think for most of you this information will be new and I promise you you don't need a bio biology or medicine background in order to understand this. It's actually really simple because it is truly elegant in design. You have three main layers of defense for your health. These are the three things that are constantly at work to protect you from invasion and illness, from bacteria, from viruses and from parasites. And the first of those three is a physical barrier that we call your skin. And that might seem kind of obvious but everything about you is contained in this compartment that is boundaries by your skin. And your skin is a very important aspect of your immune system. If you've ever had a cut you essentially have a breach of the boundary that is your immune system. And you would notice a number of things would happen. You might get some swelling around that cut. You might get a scab. Like you would get a scab over time. If it got dirty, there were some bacteria that got in there. You might see some accumulation of white blood cells. What's called pus, I know it's kind of gross but that's what that is. It might take on a yellow tint because of the accumulation of some dead cells there. But basically your skin is the primary barrier through which you keep things from the outside that could harm you from getting to the inside. Now, still in category one, your body and your external surface, you have openings to that surface. You're not just a round or body shaped completely covered up with skin. You have openings. What are those openings? Well, let's start at the top and work our way down. A primary site of potential infection or your eyes, you have your ears, you have your nostrils, you have your mouth. Those are going to be the primary sites by which things can get into your system. And you need to put things into your system. You need to drink and eat and you need to get light into your system. That's why you have those openings. But bad things, meaning things that can harm you can get into those systems. And then, of course, along the back of your throat, all the way down to your stomach and your digestive system and through your intestines and out to your rectum, you have a tube that you are basically a series of tubes. I've said that before in this podcast and this is one such tube by which you extract nutrients from the outside environment. But all along that tube, including your nose and your mouth, it's lined with mucus. And while mucus might seem kind of gross to some of you, the more you learn about mucus, the more you realize that mucus is really, really cool. Because mucus essentially acts as a filter, as a trap for bacteria and viruses. And it has certain ways of scrubbing or killing those bacteria and viruses. Now, the mucus is constantly being turned over. And as we'll talk about later, the chemistry of that mucus is really important in order to make sure that certain things don't make it into your system and other things are allowed to move through your system and you can extract nutrients from them. So the reason I'm talking about this first category of barrier for immune system and such detail is I'd like you to envision yourself as a human, of course, but as a human that is a clear entity from everything else and you have to bring in the right things and you have to keep out the wrong things or kill them. Now, inevitably, bacteria, viruses and parasitic infections are going to make their way into our body. But whether or not they are killed off or whether or not they take over and cause us harm is going to be determined by layers 2 and 3. So layers 2 and 3 are the so-called innate immune system and the adaptive immune system. So the innate immune system is what I would call the second layer of defense. It's very fast. So whether or not it's bacteria, virus or parasite, what happens when you have something enter your body, maybe you swallowed it, maybe got in through your eyes, maybe you shook somebody's hand who was carrying a particular kind of illness and then you wiped your eyes. And I've talked about on this podcast before very soon after we meet another person, usually within 30 seconds, believe it or not. Most people wipe that person's chemicals somewhere on their face or on their body surface. This has been demonstrated over and over again. If you want to learn more about that, we did an episode all about chemical signaling where you can learn about it. I know it sounds weird and you might say, I don't do that, but indeed you do most of the time. Most everybody does. Okay, so this innate immune system is this rapid response when something enters our system and our body doesn't recognize it. It's not food, it's not clean air, it's something that's either a bacteria, virus or parasite. And the innate immune system involves the release of particular cells that are waiting, dormant, ready to attack whatever this invader is. And some of these cell types you've heard of before. The most typical one are the so-called white blood cells. The white blood cells will actively go to the site of invasion and will start to encapsulate or trying surround that given invader. The other names of these different cell types are things like neutrophils, macrophages, natural killer cells. There's just a few of the many types of immune cells. So there's kind of like an ambulance system, but rather than go and try and heal something like a paramedic would, they go there and they try and surround and kill whatever this invader is. They work in concert with two other assistants and those assistants are called the complement proteins, complement proteins exist in the blood. And what they do is they travel to sites where there's an invasion and they mark certain things for being engulfed and eaten. They eat me tag on it. They basically put a chemical tag onto invaders that then allows those white blood cells, neutrophils, macrophages, natural killer cells to say, I need to basically kill this thing and then wrap it in a body bag and send it off. I'm using the analogy of the body bag, but in a sense it is one, it's the right one rather because these cells that come in and kill things, the way they do that is actually to engulf the invading bacteria virus or parasites. And when you see pus or you see infection in a, maybe a cut on the skin or something like that or even in an ingrown hair that gets some bacteria in it, that pus and that the white part, I know it's kind of gross to talk about, but those are the white blood cells and those are the dead, oftentimes it's dead cells and that's the dead invader sitting there. And I created an isolated compartment because it wants to keep it in that part of the body. Okay, so you got the innate immune system, the complement comes through blood and helps it by tagging certain things within eat me signal. And then there are the cells that are either damaged from the injury or from the parasite or are suffering because of the bacteria or the virus itself. And the cells of your body will also release an alarm signal, which is not an eat me signal, but a help me signal and those help me signals come in the form what we call cytokines. And the cytokines are things like interleukin 1, interleukin 6, tumor necrosis factor alpha. You may have heard of these things if you are at all curious about or been learning about the health space, online health space, especially in the last few years, inflammation is all the buzz word now. So everyone's talking about inflammation, inflammation, inflammation. What do we mean when we say inflammation? Well, inflammation is a physical response, but it's also a chemical response. And many times the markers of inflammation that are measured in people or an animal model, excuse me, where this research is done are things like interleukin 1, interleukin 6, tumor necrosis factor alpha. And when those go up in the blood, it's a sign that somewhere there's a cell that's saying help me help me and is secreting these things which calls in those neutrophils macrophages natural killer cells and white blood cells. And it might help to remember all this, but by just telling people that what interleukin means is to communicate. Right. And once you're looking at shouting out help me the compliment proteins are coming in and saying eat this and tagging the invader within eat me signal and then the killer cells and the white blood cells are doing the job of trying to kill off that thing. That's the innate immune system so that your skin and your mucus lining plus your innate immune system are a beautiful two layered set of defenses against various kinds of invaders and infections. And there's the third type which is the adaptive immune system and you'll notice that leading up until now I haven't said the word antibody at all and that's because it is the job not of the skin or the mucus or the microbiome or the innate immune system to produce antibodies that can recognize specific invaders, but rather it is the job of the adaptive immune system to create antibodies against bacteria viruses and even parasites and even physical. Intruder is to your system so the adaptive immune system has this incredible ability to show up at the site of invasion or infection or inflammation it's called there by various various cues including the cytokines that we talked about earlier. And what it does is it actually attaches to and creates a sort of an imprint of the shape of whatever invader happens to be there. So if that particular invading bacteria virus has a contour that's kind of rippled or kind of spiky or whatever shape it happens to have it creates an imprint of that. And then using that imprint in concert with some other cells creates antibodies that are specific to recognize that invader should the body ever have that invader inside of it again. Now that's why it's called the adaptive immune system and in many ways it creates a memory of a prior infection so that these antibodies can be made anytime that same invader comes back again. And so this is the basis of what we call immunity. This is the basis of what we call an enhanced ability to combat certain types of infections. And it's really a wonderful and I mean just I can't even state how incredible this really is that all of our bodies have this capacity right. We have something called leukocytes. These are essentially white blood cells. We have red blood cells and white blood cells and they both are derived from the same type of origin cell. It's a stem cell when you hear stem cell stem cell just means a cell that can become many different types of other cells. We sometimes hear about stem cells in terms of people that are getting injections of stem cells or the potential therapeutic effects of or potential of stem cells but we all harbor certain stem cells within us as well that can become lots of different cell types. And there's one particular type of stem cell which is the hemopoietic stem cell which can give rise to red blood cells and white blood cells. And in general these reside in the marrow at least in adults. So in our bone marrow we have this ability to make certain cells that can go out when they are called out chemically. They're called out to sites of infection and create antibodies and then maintain those antibodies in our system or have a memory of that particular infection. So that if the infection comes back again we can kill it off immediately and it doesn't have to pass through these multiple stages of first the innate response then the adaptive response taking some time. There are a lot more details to the adaptive immune system but I just want to emphasize a few points that might be relevant. First of all the name of the antibodies that are created sometimes come in the form of IgM and IgG, things that sort. This isn't a full deep dive immunology class but Ig stands for Immunoglobulin. Okay so the immunoglobulins are part of the adaptive immune response and creating antibodies. If you hear IgM the IgM is the first of the adaptive immune responses and it tends to come on earlier. So if somebody is immunopositive for IgM for a particular type of viral or bacterial invader that means that it was a fairly recent infection. Later one creates the adaptive immune system I should say creates an IgG which is the more stable form of the specific antibody that's going to recognize a given invader. So IgG tends to come up a little bit later. So just to recap something gets into your system through your eyes through some hole in your skin, a cut through your mouth sexually transmitted diseases come in through the mucus membranes that are on the genitalia. Or in the genitalia sexually transmitted disease airborne disease gets into the mucus somehow gets into the bloodstream then there's the innate response which is a more general response of trying to contain and combat the infection or invader. And then the adaptive response is the one that generates the antibodies first the IgM response the immunoglobulin M response and then the immunoglobulin G response IgG response. So how do we keep these three barriers or these three defense systems to infection tuned up? Well, leaving aside the list of things that I mentioned before that generally enhances their function things like sleep and sunlight and good nutrition etc. The sort of generic things for good health. One of the key ways we can do that is to keep that mucus lining in really good shape and what does that mean? Well, the mucus lining needs to turn over quite often and it needs to be the correct chemistry to be a trap for the bad stuff and for it to be permeable to the good stuff to the nutrients that we need. And it is now very clear from hundreds if not thousands of studies that the best way to do that is to maintain a healthy so-called microbiome. The microbiome being these little bacterial organisms that are good for us that live all along our mucus pathways and even in our eyes. Now, just to be really clear, it's not just about the gut microbiome. We actually have a microbiome in our eyes. We have one that's specific to our mouth. We have a nasal specific microbiome. There's one all along the gut and the species of microbiota that live all along the digestive tract differ from the mouth to the throat to the stomach intestines into the rectum. It's well established that there are healthy microbiota that live all along that length and they differ along that length. There's also a urethral microbiota and there's a vaginal microbiota that promotes health of that environment as well. So how is it that one can maintain the healthy microbiota and not favor growth of harmful bacteria or allow that mucus lining to become too permeable to the bad stuff that can come in from the environment? Well, as far as we know, there are three main ways to do that. The first two are purely structural and mechanical. It's very clear now from work, some of which was done at Stanford, but elsewhere as well, that the nasal microbiome is particularly good at scrubbing bacteria, at preventing certain types of infections. So this is a reminder that whenever possible, unless eating or speaking, you want to be nasal breathing, not breathing through your mouth. Your nose is a much better filter for viruses and bacteria than is your mouth. The mouth contains certain structural features, even organs and cell types that can protect against incoming infection. But you don't want to be a mouth breather for a variety of reasons. And there's a terrific book called JAWS, a hidden epidemic, which is written by my colleague Sandra Khan and Paul Erlich at Stanford and Stanford Medicine with a forward by Jared Diamond and Robert Sapolsky. So it's really a lot of heavy hitters on that book that talks about the increase in infection that one gets when breathing through the mouth as opposed to the nose. Now of course during hard exercise, one reads through the mouth that's not necessarily bad when one is eating or speaking. That's not necessarily bad at all. I guess it depends on what you're saying. It was a joke. But in general, when possible, you want to be breathing through your nose. Many people have trouble breathing through their nose because of so-called deviated septums or chronically collapsed sinuses. The best way to dilate those sinuses is actually to breathe through your nose. So it can take a little bit of time, but there is some plasticity to the sinuses. And so be a nose breather, not a mouth breather. You will combat more of the infections that you are constantly confronted with. I should mention that we are always bombarded with different types of bacteria, viruses and parasites in our environment. And the goal of course is to reinforce your immune system so you can keep these things at bay and not get sick. There's actually a paper that was published in cell reports, Cell Press Journal, excellent journal that showed that the nasal microbiome has particular species of microbiota that are good at fighting off infection. There has not been a direct link between particular patterns of nasal breathing and the nasal microbiome yet, but oxygenation of that environment by breathing through your nose turns out to be quite important overall for enhancing it as a filter. So don't just think of your nose as something to smell foods and to bring in air. It's also an active filter for things that could invade you. Another way to try and keep out bad things and to avoid getting sick is the advice that your mother and certainly my mother gave me, which is to not touch your eyes after touching other people or touching other surfaces. And as I mentioned earlier, we tend to do this subconsciously. But the reason to avoid doing that is the eyes are a primary entry point for a lot of bacteria and viruses. You're constantly lubricating the surface of your eyes with the so-called lacrimal glands and tears and things of that sort. If you've ever noticed when you wake up in the morning, you have some sleep in your eyes, either kind of crusty stuff in the corners of your eyes or on your eyelashes. That sleep, that crust, are actually dead bacteria that you've successfully battled during the night. That's what that is. Not the accumulation of some healthy tissue. It's the accumulation of that your healthy mucus membranes and tears and other things that are specifically combating those bacteria. So I know that sounds a little bit gross, but that's what that is. So you're wiping away the casualties of a battle that you fought at night. So during the daytime, you don't want to introduce viruses and things to your eyes as much as possible. It is a primary sight of entry. This is why people wear goggles in surgical units and things that sort to try and avoid getting things into their eyes. Very, very important. And then the third way to keep a healthy line of defense for your entire mucus tract is to enhance the proliferation of good gut microbiota. The best way to enhance the quality of your gut microbiome and the mucus lining that serves as this protective layer along your body is to ingest two to four servings a day of fermented foods, low sugar fermented foods. I've talked about this before a bunch of times on the podcast, but these are data from my colleague Justin Sonnenberg's lab at Stanford Med and there I just wiped my eyes. Yep, you got me. But that a paper published in the journal cell, which is a absolutely spectacular journal, really points to the fact that when people eat fermented foods, two to four servings per day, it helps reduce the activity of certain cytokines. Now, you know what those are, right? Cells make cytokines to call out, help me help me to reduce the amount of cytokines, the so-called inflammatory. Now, that doesn't render those cells more vulnerable. The reason they saw a reduction in IL-6 and IL-1 and some of these other cytokines is because when people have a healthy gut microbiome, there are fewer cells in the body being infected from outside infections. And therefore, less of a reason for cells to be crying out, help because they are thriving, not suffering. So, don't wipe your eyes. Keep your hands clean. Everyone tells you that, right? But keep your hands clean. Don't wipe your eyes. Be a nasal breather, not a mouth breather, unless you're speaking, exercising or eating. And keep a healthy gut microbiome by eating two to four servings a day of quality low sugar fermented foods, things like sourcrow, things like notto. If you can access that, I've tried it before. It's interesting. It's sort of an acquired taste. Kim Chi pickles, again, low sugar sources are going to be the sources that are going to be most effective for this. So now you're armed with three ways to enhance the function of your immune system and combat infection that is, I like to think separate from the typical type of information that you get, such as, you know, get good sleep, good nutrition, good social connection, etc. All that stuff still holds true. But these three other points, I think, can really make a substantial difference in terms of bolstering the immune system, your immune system. You want to mention, because these names are going to come up several times during this episode, that while interleukins like IL-6 and IL-1 encourage inflammation, they are these help me signals that call in cells to gobble up invaders. There are some interleukins that are anti-inflammatory, and the one that I'd like to highlight in particular, because it will come up again in a little bit, is interleukin 10. So not all of the IL-insert number, not all of the interleukins are inflammatory. Some are anti-inflammatory. So that's an important point to keep in mind as we go forward. Next, I'd like to talk about what's called sickness behavior. And indeed, there is a category of behavior that we call sickness behavior that is very informative as to the things that we can do to avoid getting sick. Now, this notion of sickness behavior goes back several decades or more, and it's a very interesting way of looking at the function of the immune system, because what it does is it bridges us from this thing that we're calling the immune system where it's safe. It's a very important thing to do when we're using the immune system where it's T cells and B cells and cytokines and leukocytes. And it starts taking us into the realm of the nervous system because, of course, the nervous system controls behavior. So sickness behavior is a suite of responses that we tend to all undergo when we are feeling sick. So this is going to vary from person to person, but there's some general categories of things that we all do and that happened to all of us. So the main thing that is being treated in a way that is a very important thing to do is to take a person's brain as a person who is feeling sick. And that's what the immune system is. And the main thing that's being treated is that it tends to involve a slowing of our usual levels of activity. People start to feel lethargic, or they feel like the activities that previously they could do with relative ease are very difficult for them or somewhat overwhelming. The other thing you start to see is that people and animals, by the way, stop grooming. They stop taking care of themselves, not necessarily stop showering, although oftentimes that's the case, but they will stop doing their hair. They'll stop putting on makeup, depending on whether or not they did that before. They might stop. Animals will stop licking and grooming themselves. People will stop taking care of their cosmetic appearance. Now it's not just because they don't care how they look when they're sick. It's because there's this overall suppression of certain kinds of activities and an enhancement of other kinds of activities. And this is really important. Sickness behavior is actually a motivated state. It's a state that's designed to accomplish certain things. One of the other features of sickness behavior, and addition to being lethargic, loss of grooming, will be a loss of appetite. Oftentimes people who have a great appetite normally just won't feel hungry at all. There are several theories as to why this would be. One prominent idea in the literature is that it's to discourage vomiting and diarrhea, which of course can be infectious to other people. So that's a theory. I don't know that that's ever been tested directly, but that's one idea. The other idea is that it's simply to harbor more resources for sake of repair. And I want to talk about that because we are all told to get extra sleep when we aren't feeling well or to rest. But just like any good two or three year old constantly asks why? Why? Why? Good scientists, good people who are interested in health information should always be asking why? Why should I get more sleep? What happens in sleep that I should get more sleep when I'm sick? Why shouldn't I just push through this? And there are a couple of reasons for this that have been established in the literature. The first is that there does seem to be something useful about slowing circulation when we are ill. One idea that has some data to support it is that when we slow our circulation, our blood circulation, you know, so not running around so much or running at all, but rather lying down, getting extra rest, maybe sleeping, maybe even just remaining still, is that the lymphatic system, which carries a lot of the immune related cells and fluids, is able to ramp up its levels of activity. So this is interesting, right? So reducing circulation of the blood, but increasing circulation of the lymphatic system. You've all probably been familiar with the lymphatic system. When you're combating an infection, your lymph nodes can get sore. You've got lymph nodes behind your ears and you're growing your armpits around your throat, around your thyroid, and your throat, etc. So that's the other reason. Now, some people when they get sick, psychologically, go into a very vulnerable state where they really, really want people, other people to take care of them. You've probably witnessed this, or you feel this way yourself. About 50% of people have that response. They really want to be taken care of. Now, when you think about it from an adaptive perspective, this makes sense, right? A member of our species is ill, and they more or less will cry out for help in one form or another to the other members of their species to take care of them. And of course, this will be especially apparent in cases where people are young enough or incapacitated enough that they can't actually get resources on their own. If you've ever been really sick, just getting up and going to the fridge or to the restroom can feel like a monumental task. So about 50% of people report or describe seeking of help and support when they are sick. But you could also imagine how this would be a very non-adaptive response because it increases the opportunity of spread infection to the caretaker. So that's an interesting consideration. Another 50% of people seem to have the opposite response when they're sick. So somehow, regardless of how they were prior to getting ill, the sickness behavior that's engaged by these neural circuits in the brain, they are indeed neural circuits in the brain, create a stay away from me. I don't want to be bothered. I want to be left alone. I don't want to be taken care of. It's not stubbornness. It's literally a lack of interest or a disinterest in social connection when one is sick. And you see this in animals too. Some animals will seek out other members of their species. Others like my unfortunately now passed away bulldog Costello when he was sick. I always knew because he would go around the back of the house and he would just hide there. He would just take himself away from everybody else. He did not want to be taken care of. It was just a natural response to him. I don't think he was trying to prevent me from getting whatever it was that he had. So if ever somebody doesn't want to be taken care of or if they do want to be taken care of, realize that people tend to fall into these two bins. Naturally, animals tend to fall into these bins. Regardless of what species they are, it's about 50-50. And again, this sickness behavior is a motivated state. It's designed to slow circulation of the blood, increase circulation of the lymph and the other killer cells in the body. Reduce the probability of infecting others by reducing its thought, diarrhea, and vomit, but also breathing on others, interacting with others. And in some cases, it will activate this. I don't want to call it a regressed state, but many people feel somewhat more, if they are adults, they feel more childlike when they are ill and they want to be taken care of very badly. Some of it might be learned, some of it might be innate, we don't know. But the sickness behavior is very interesting for a couple of reasons. First of all, it mimics another state that has been described in the neuroscience literature, which is major depression. And in both sick individuals, sick from bacterial viral infection, and in people with major depression, it's been shown that there are robust increases in the levels of interleukin-6 and tumor necrosis factor alpha. So there is an idea now circulating that depression involves these inflammatory cytokines being very active, and we know that illness involves inflammatory cytokines being very active. So if you think about it, the similarity between major depression and being sick ought to be able to point us in a direction of interventions that could help us either prevent illness or move through illness more quickly. But as we head in that direction, because indeed that's the case, I just want to emphasize that sickness behavior is what provides this bridge between the immune system and the nervous system. And what we'll soon see also is that healthy behavior, behavior that allows us to avoid infection also points to a clear bridge between the nervous system and the immune system. That it isn't just that we have a brain and body and our organs, and then we have an immune system. That's true, but they're interacting all the time. And this is going to lead us to a place where it's going to be very clear and not at all surprising how certain patterns of thinking and certain behaviors that we can elect to take can help enhance our immune system function and vice versa. There are two other features of sickness behavior definitely worth pointing out. One is a theory, which is that the reduced appetite in particular appetite for protein rich foods when sick is thought to be an attempt, a subconscious attempt, of the organism to reduce the amount of iron that it's taking in. Now, typically the amount of iron intake that's recommended or more or less is for men. It's about eight milligrams per day for women. It's anywhere from 18 to 27 milligrams per day depending on whether or not they're pregnant, lactating or menstruating, etc. The ranges can vary. But, and indeed it's true that if iron levels in the blood go too high, like over 45 milligrams per day can be very toxic to the system. But, the theory that's prominent in the biology literature and in the health literature is that the reduction in appetite is actually an attempt to reduce iron intake specifically because many bacteria and other forms of infection seem to thrive when levels of iron in the blood are high. Now, I don't want to see anyone take this to extreme and suddenly do an iron deprivation diet in order to get well. But, it's an interesting theory that I'd be remiss if I didn't mention because it makes good sense. Iron is actually attached to hemoglobin and red blood cells in the bloodstream. Normally, that can help us quite a lot. It's also in muscle, I should mention that. Iron can be sequestered into muscle. And, iron serves a lot of important health promoting roles. But, by reducing appetite and thereby reducing iron intake, it does reduce the capacity of certain things including infections to travel in certain compartments within the body. So, again, that's just theory, but I think many of you are probably familiar with not having an appetite when you're sick. The other thing that's very typical of people with major depression is loss of appetite. Not always, but often loss of appetite. So, here again, we have loss of appetite and sickness behavior, loss of appetite in major depression. And perhaps not surprisingly, one of the major symptoms of sickness behavior and major depression that map, more or less, onto one another, is loss of libido or interest, not just in social interactions, but in sex and reproduction. And so, again, if you think about sickness behavior and depression, they are very, very similar. Okay, so, sickness behavior and major depression have certain core features in common. We need to therefore ask ourselves, why and how does being sick influence the way that we think and perceive our environment and impact our appetite, whether or not we want to be cared for more or cared for less. Again, people tend to diverge into two different bins there. And believe it or not, the pathway for this has been identified when we have an infection someplace in our body. And it could be up in our head, it could be a sinus infection, it could be an ear infection, or I should also mention many of these same mechanisms can also be the consequence of a wound or an injury to the body. Back injury or a slip disk, or I guess it's called a herniated disk, is the way that you here described. When we have that, we can be kind of irritable, we don't want to do certain things, and we just want to be left alone. Things are harder, how? Why? Well, there's a known pathway, which is the so-called vagus nerve that connects the body and the brain, signals to particular brain sites to engage this category of disease. It's a category of motivational state that we call sickness behavior. Many of you have probably heard of the vagus, VAGUS, the vagus nerve is a very extensive nerve pathway, the 10th cranial nerve comes out of the back of the brain stem, heads into the body, and branches out extensively to innovate or connect to many of our organs, including our lungs, our heart, our gut, etc. Those organs are able also to send neural signals back up to the brain. We sometimes hear the vagus as the route to calming ourselves down. Unfortunately, that's more or less a myth that I don't know how it got propagated. You have lots of different pathways in the vagus. Usually, vagal stimulation actually creates more arousal and alertness, although it does have multiple pathways. But there have now been many studies of the vagus in various contexts, including in sickness behavior, and it's very clear that the vagus nerve is the fast pathway by which an infection in the body is signal to the brain to a particular location in the brain called the hypothalamus, which harbors a lot of different types of neurons. For instance, in the preoptic area that increase body temperature and fever, that's one of the most important things is to increase body temperature in order to kill off this invader. Many viruses and many bacteria don't survive well at elevated heat. That's the function of a fever. A fever actually has a functional role. So in biology, we like complicated words, so we call anything that increases body temperature or creates a fever, a pyrogen many years ago. In my undergraduate years, I was working on pyrogens, injecting something called lippy polysaccharide into the belly, which then gives you a fever. The way it does that is LPS causes an inflammation response in the gut. The gut doesn't know what is happening. The stomach cells don't know what's happening. So they just start secreting the IL-6, the IL-1, all those cytokines that kill ourselves, migrate into the gut. That's why you sometimes get a stomach ache when you don't feel well, you have a flu or something like it. A neural signal, electrical signals get sent up to the hypothalamus, the hypothalamus says, oh, I don't know what's going on out there, but there's a signal something's going on. Let's just heat up the body. Let's just start cooking whatever it is out there. Of course, you don't want fever to go too high because you can kill brain cells, but within a particular range, the fever is a functional and adaptive response. If you're taking drugs to try and lower the fever, that might make you feel more comfortable, but actually that's limiting the response that your body is creating in order to try and kill off that invader. And again, you don't want fever to go too high. This is going to vary depending on age. You can look up online with the tolerable ranges R for fever, but when you're trying lower body temperature, when you have a fever, unless you're heading into dangerous levels of heating up, that's actually the wrong way to take your system if you do indeed want to kill off that invader. Okay, so the Vegas nerve is the quick response. It also sends input to areas of the brain that change your perception of the outside world. One of the most obvious of these, obvious, once I tell it to you, is photophobia. I love bright sunshine. I love bright lights when I want to be alert. We all have different levels of light sensitivity, but most people, when they are sick, when there's an inflammation response in the body, they feel like bright lights are kind of aversive. They get a well-described kind of classical photophobia. And that's mediated by a pathway that goes from your eye to an area of your thalamus, called the anterior nucleus of the thalamus. This is work that was done by Clifford Safer at Harvard Medical School. It's really beautiful work. And then from there, up to the outer lining of the brain, which is the meninges, just sort of on the outside of the brain, where the brain starts to interface with some of the other connective tissues, we'll talk more about these later. It can actually create a photophobia and a headache when one is ill. So here's the pathway. Some invader gets into your system because you wiped your eyes or got in through your mouth, you didn't listen to your mother and got in through your eyes. You're feeling sick. Something's going on there. You have a stomach ache because of all the inflammation there. The signal goes up from your vagus nerve. You're heating up with a fever. You've got photophobia because you've activated this pathway by which what would normally be tolerable light is triggering this thalamic nucleus, the anterior thalamus. That's projecting up to the meninges. You've got a headache in response to looking at light. It's basically triggering an overall pathway to get you to go into a quiet, dark place and rest. The last element I'd like to talk about is the rest. There's something that gets triggered from the body to the brain to the hypothalamus. We think we know which hypothalamic area it is. It's the super optic nucleus we think. It's super optic because it's right above your so-called optic chiasm. If you want to look up where that is, it's right above the roof of your mouth. There are nuclei there that promote the desire to sleep even during the daytime. What would normally be the active phase of your circadian cycle. That is really interesting because what's happening here is you've got multiple pathways that are saying avoid light. Reduce your amount of behavior, heat up all the things that are making you sick. This is sickness behavior and it's going from your body to your mind to make you do the right thing. Now there's also a slow pathway that's purely mediated by the blood, so-called humoral factors. Not because they're funny, but humoral factors are factors of the blood. As you have an infection for many hours or days, the amount of IL-6 and IL-1 and tumor necrosis factor and other inflammatory cytokines is starting to increase such that the total amount in your circulation gets high enough and is communicated to the brain. It tends to enter the brain through a particular type of tissue that's really interesting called coroid. CHORoid is really interesting. It's kind of this fluffy tissue that sits in your ventricles. The ventricles are the spaces in your brain and the spaces in your brain have what's called cerebral spinal fluid in them. The cerebral spinal fluid contains a number of important things, but the coroid starts releasing and responding to these cytokines, the inflammatory cytokines. Then the brain actually starts to experience all sorts of changes in terms of inflammation to neurons, your memory tends to get poor, your cognition tends to get poor. These are transient things, most often, these things will pass, but this is deep into sickness when you're really feeling lousy. You can't read, you can't watch a movie, you can't do anything. If you ever get sick and you just can't be bothered by anything, it's probably because you've had that fast response from the body and you've also had this slower response where you literally have a set of tissues in your brain that are sending out these inflammatory signals. Now your whole brain is starting to cope where it's trying to cope with this infection. You've got a slow pathway and a fast pathway. That all sounds really terrible. Now I'd like to talk about what you can do to reduce the probability of getting sick. There are actually things that one can do as you start to get sick and once you're sick to accelerate the healing process by flipping the equation. Up until now we've been talking about how the body activates certain areas in the brain to create sickness behavior that's very much like depression. You're probably all familiar with this from any time you've had a cold or a flu or something really lousy or an injury. Now let's flip the equation and ask what can we do with our nervous system in order to enhance the function of our immune system in order to be able to heal and recover from illness and injury more quickly. So let's say you are in that unfortunate circumstance of waking up one day or coming home and you've got that tickle in your throat or when you breathe your nasal passages don't feel the same way. You've got a little bit of a headache. You're feeling kind of off. We all know what we should do. We should all hydrate during some water and go to sleep. That's what we're all told. But there are actually things that you can actively do in order to get your immune system to deploy a more robust response at that early phase of potential infection. Let's focus first on the rest component. Yes, of course we are all told that we should take a hot shower and go to sleep and get 9 or 10 hours of sleep. But there's an interesting way of looking at sleep specifically for its role in enhancing the immune system. And there's a wonderful review. I'll put the review in the captions that looked specifically at the literature surrounding sleep that is different because it occurs in support of the immune system. Normally when we go to sleep we have slow wave sleep predominantly in the early phase of the night and then over time as we sleep longer and longer we get more so-called REM rapid eye movement sleep. Talked all about this on the episodes on sleep. Of course you have slow wave sleep and REM sleep throughout the night always but it's the fraction of slow wave sleep to REM sleep the shifts. And they have different functions etc. There is some evidence that the sleep associated with an infection in particular early stage of infection is associated with elevated levels of serotonin in the brain that either through an adaptive mechanism or for whatever reason the brain, the neurons in the brain of the so-called Rafa, and then we start releasing more serotonin and that that serotonin in its related pathways can help enhance some of the immune system function that could combat the infection. There is starting to be some data and I emphasize starting because it's not a very robust literature yet. We can get whether or not supplementing precursors to serotonin like 5HTP, which can be taken in supplement form, or consuming foods that increase serotonin naturally. So these would be any foods that contain high levels of triptophan. You can look up what those are. So white meat turkey for instance, certain complex carbohydrates can often be rich with triptophan. Consuming those foods can enhance the amount of serotonin that's available in the brain and blood and thereby lead to the particular quality of sleep that allows for more deep healing or for when I say deep healing I mean for a more robust immune response. Now again those are still emerging data. What is very clear however is that during sleep and in particular during sleep that's associated with the early stage of any kind of viral or bacterial infection, the so-called glimphatic system is much more active than it would be normally. What's the glimphatic system? The glimphatic system is actually a relatively recent discovery. I mentioned lymph and the glimphatic system earlier, the glimphatic system with a G is a system in the brain by which debris that accumulates throughout the day but in particular debris that accumulates under conditions of neuro inflammation and inflammation of the body is cleared out or is washed out of the brain. The activity of this glimphatic system is extremely important for the recovery from infection of any kind and it's now becoming clear is important for recovery from traumatic head injury and maybe even from psychological trauma. So the glimphatic system is it can be thought of more or less as a plumbing system that runs through the ventricles but also mainly through the lining that sits between the brain and the skull and some of the other tissues and things of that sort the corroid is involved as well. Brain imaging reveals the glimphatic system is very active during deep sleep and there's this kind of wash out of the glimphatic system and I'm aware of some studies that are ongoing now where augmenting the serotonin system through either supplementation of triptophane or 5-HTP or even serotonin itself these are laboratory studies is being looked at for its capacity to increase the amount of circulation in the glimphatic system and the ideas that it might and I want underscore might potentially lead to more rapid recovery. From injury and illness and potentially ramp up if you will the activity of the immune system so it essentially is it ramping up of the activity of the immune system now regardless of whether or not you decide to for instance supplement with 5-HTP before sleep or not I'll talk about what that might look like in a moment. There is a way that you can increase the activity of your glimphatic system under normal circumstances because of the mechanics of the glimphatic system it turns out that if you elevate your heels by about 12 degrees it doesn't have to be exactly 12 as you sleep by putting maybe a rolled pillow or two pillows underneath your feet by having the head below your legs it seems that there's more glimphatic wash out or clearance during sleep and this is without taking any compound to adjust. So I would say if you're not feeling well yes take the hot shower yes get into bed and go to sleep but elevate your feet to try and increase the activity of the glimphatic system. Some might even consider that if you have to be awake that you might want to be awake with your feet elevated above your head now that might not be practical for the workplace but it might be practical for a short nap during the day or something of that sort. Glimphatic system is not just active during sleep it's also active during certain phases of waking in particular when we are in a deep state of relaxation so as many of you probably know I'm a big proponent of self hypnosis because of the quality scientific literature on this if you're interested in self hypnosis you can go to reverie our EVRI dot com. Reverie is a cost free app for apple and Android that was developed by my colleague David Spiegel and others at the Stanford University School of Medicine based on quality studies and peer reviewed data showing that deep states of relaxation can be used to improve pain management improve transition time to sleep and a number of other other things you can select the various things that you're seeking using reverie it's a great thing that especially for people that are challenged with meditation could use because you just listen to the script involves deep relaxation I would suggest using that script but with or the script for sleep but with feet elevated to increase activity the glimphatic system now if you do decide that you want to test out this serotonin hypothesis on your own obviously check with a doctor I'm not a doctor I'm a professor so I'm professor things not suggesting things but 5HTP is a supplement that I've talked about before on this podcast that I actually do not recommend for most people for sake of sleep because it can disrupt the normal architecture of sleep and create a deep sleep early in the night and then a spontaneous waking with some trouble to get back to sleep and that's because the way that the serotonin system and the melatonin system interact however under conditions where one is feeling like they might have an infection or an early stage of illness in that case 5HTP might be a useful supplement in order to access these states of sleep that are not typical they're not the typical deep sleep that you would achieve on when you're feeling healthy these are states of sleep that are specifically there in order to try and repair some of the immune system related inflammation that's occurring if you'd like to explore the 5HTP approach and you feel it's right and safe for you and you've talked to your doctor it's 300 to 500 milligrams taken about 30 to 60 minutes before going to sleep for the night that's the typical protocol not incidentally increasing serotonin is also one typical approach for the treatment of major depression this is the basis for things like SSRI selective serotonin reuptake inhibitors like pro lack excuse me prozac and zooloft and so forth the 5HTP approach is a much milder approach than prescription drug of course but will allow more serotonin to be synthesized and or released now for those of you that are interested in the learning more about the glimphatic system it's a fascinating system and you might want to do a deep dive there in terms of the behavioral protocols and what's known about it there's a wonderful article called the glimphatic system a beginners guide is a scientific article the first author is jesson is the last name gj ss en if you put in jesson the glimphatic system of beginners guide you can access the full length manuscript easily online it'll show up immediately in your search and in a really interesting way the glimphatic system has now also been tied to the iron deposition system early we were talking about iron and how of course getting enough dietary iron is important but if levels of iron are too high it isn't good for a number of reasons there's a very interesting article that just came out last year called dysfunction of the glimphatic system might be related to iron deposition in the normal aging brain so we're starting to see these links between iron levels being too high the glimphatic system not being active enough and so forth leading to sickness behavior inflammation and maybe even damaged neurons associate with aging we can flip that on its head and say that increasing the activity of the glimphatic system feet elevated during deep sleep maybe even feet elevated above the head while awake during a nap or doing a reverie script once a day or something of that sort could increase the activity of the glimphatic system lowering iron to a point that's probably below the typical intake during periods of infection perhaps perhaps I should say can enhance the glimphatic system and vice versa and then you've got this specialized sleep that's related to sickness behavior that seems to have heightened levels of serotonin that might be augmented by increasing it's excuse me that might be augmented by ingesting 5-HTP again not on a regular basis I don't suggest that people take compounds that increase serotonin unless it's prescribed you for depression or something but not doing it by supplement with trip to fan or 5-HTP on a regular basis but only under conditions where as I mentioned you might be starting to feel sick or you're coming down with something or combating some sort of infection so if we consider the advice that we typically get when we're not feeling well of take a hot shower get into bed and go to sleep and we've now touched on ways to potentially increase the efficacy of the sleep part through the glimphatic and the serotonin system what about the take a hot shower part is that good advice well it turns out it is and there's actually a way to do even better there's a study very interesting study the title reveals where I'm going with this it's effect of a single finish sauna session on white blood cell profile and cortisol levels in this case it was done in athletes and non-athletes which is kind of nice this involves taking athletes and non-athletes and exposing them to sauna it wasn't particularly hot it was 96 degrees which isn't cool but it's not really hot nowadays you hear about people doing very very hot sauna the humidity of the sauna if you want to know is 15 plus or minus 3 percent but basically what they found was that just one 15 minutes sauna session could really increase white blood cell profiles and could adjust cortisol levels in ways that were beneficial for combating infection and now there are many other studies like this now this should immediately make sense based on what we said before about fever heating up can actually help combat infection but for those of you that have listened to the episodes on temperature what you probably know is that when you get into a sauna or any kind of hot environment your body is also going to be actively pushing to cool itself off so there's probably an increase in heat there is an increase in heating that then afterwards your body will cool off maybe even with a dip below baseline I do want to provide a cautionary note that if you are already running a fever getting into a sauna could take your body temperature into dangerously high levels dangerously meaning you can kill neurons and once you kill neurons they do not come back so please don't kill your neurons I don't recommend getting into a sauna if you're already running a fever so this would be something to do at the initial stage of an infection or if you're feeling a little bit off so this is kind of a ramping up or a super protocol of the typical advice of take a hot shower and get into bed that is good advice now we're talking about a hot sauna probably showering off and then getting into bed maybe augmenting serotonin I know many people don't have access to sauna so in that case a very hot bath or shower don't scald yourself of course but as hot as you can comfortably tolerate or you know right at that edge of what you can tolerate would be a good idea some people I've heard are creating saunas in their bathrooms by running hot water and creating a ton of steam anything that really heats you up but not to dangerously high levels is going to be beneficial if you have access to a sauna terrific this again was only 15 minutes they had a cool off session would you get more of an increase people always want to know if you did it twice as much would you get twice increase those data don't really exist yet however if you are interested in maximize in the effects of sauna it is clear that a cool off period is important so it's not that at 15 minutes sauna is good and a 30 minutes sauna is better if you are going to take that route of exploring more it does seem that doing a 15 minute heating period followed by a five to ten minute cooling period and then getting back into the heat can be beneficial and this is interesting it gets to the mechanisms by which the hypothalamus that areas the areas of the hypothalamus that is that generate increases in body heat the activation of those neurons occurs as you heat up and then were you to just stay in that heated environment they would actually shut off and some other neurons would be handling the job so to speak but by getting in and out of the heated environment you actually force that system to send repeated pulses of these cortisol lowering and white cell stimulating signals to the body some of you have probably heard the phrase feed a fever star of a cold I don't know who first said that I couldn't find the citation but we hear this and we can speculate that the reason that phrase feed a fever star of a cold came to be is because of the adaptive function of fever that increases in body temperature make it challenging for intruding viruses and bacteria to survive even though of course highly elevated body temperatures pose a danger to the host organism to you eating does cause an increase in body temperature through the so called thermogenic effective food so I can understand the logic of feed a fever it would mean that when you have a fever it's your body's natural attempt to heat up and kill some invading thing and by eating you would further increase your body temperature why you would want to starve a cold I don't know however maybe it's because when your nasal passages are congested it's uncomfortable to eat or something of that sort so the feed a fever part makes sense to me that the star of a cold part is still mysterious to me I couldn't find any logical reason why that could be good there are communities out there that believe that fasting is a viable way to combat certain types of infection fasting in particular prolonged fast do increase the amount of adrenaline also called epinephrine in the brain and body and as we will next explain epinephrine adrenaline does have a powerful effect on the various inflammatory cytokines and on the immune system in general so let's talk about a behavioral protocol that anyone can use it doesn't involve any equipment you don't need a sauna you don't need anything at all that has been demonstrated in excellent peer reviewed research to enhance the function of the immune system and actually allow people to combat infection in very dramatic ways next I'd like to do an in-depth analysis of a study that has achieved some prominence out there not just in the scientific literature but on the internet because it relates to how particular types of breathing can impact the immune system and the ability to combat infection the title of this paper is voluntary activation of the sympathetic nervous system and attenuation of the innate immune response in humans this is a paper that was published in P N A S which is the proceeds of the National Academy of Sciences USA it's a very prestigious journal those of you that know P N A S you know that there are certain papers published in P N A S or there used to be that were not peer reviewed in recent years I think all of them have moved to peer reviewed paper so this is a peer reviewed very high quality study and I just wanted to describe the basic contour of the study I'll explain the findings and then I want to go in depth and explain the mechanistic basis for these findings and the protocol that we can all export from these findings so here we go first of all a couple of terms so that everybody is on the same page the sympathetic nervous system is one division of our nervous system it's a set of neurons down the middle of our spinal cord and in our brain that generally lead to a heightened state of arousal and alertness it's associated with epinephrine release in the brain and adrenaline release in the body it's the so-called fighter flight system when it's really active but it's the system that's active when we are wide awake and we already talked about the innate immune system that's that first line of defense after the skin barrier of course whereby some infection comes into the body and there's this rapid response of increasing inflammation and that's also about the time that you first feel lousy when you start to feel like I think I've got something I don't feel right a headache I feel nauseous I'm heating up I don't feel good that's that's the the innate immune system kicking in so what they did in this study and by the way I should say they this is the first author is Cox KOX last author last name pickers PIC KKER S what they did was they exposed human subjects to an endotoxin by inject in other words they injected people with E. coli there's a bacteria which makes people all people feel terrible so nauseous fever vomiting diarrhea very unpleasant okay these people voluntarily signed up for this study however some of the subjects in this study performed a behavioral protocol that can best be described as cyclic hyperventilation my lab works on these types of breathing protocols this is not worked at my lab did but basically subjects hyperventilate followed by breath retention by breath holds and I'll explain exactly what they did they also looked at other forms of behavioral protocols but let's focus on that one so they're comparing controls that do just sort of a basic meditation versus people that do this intense breathing followed by some breath holds I'm just paraphrasing here in the intervention group the breathing group plasma levels of anti-inflammatory cytokine IL-10 so this is a cytokine that is lowers inflammation increased after endotoxin administration and that was triggered by an increase in epinephrine in adrenaline so in other words doing a particular pattern of breathing allowed an anti-inflammatory cytokine to be turned on whereas that was not the case in the subjects that did not do this particular breathing protocol and they discovered that levels of pro-inflammatory TNF alpha tumor necrosis factor alpha IL-6 interleukin-6 and interleukin-8 which you should all be familiar with now as pro-inflammatory cytokines were lower in the intervention group whereas these IL-10 levels that are anti-inflammatory went up finally flu-like symptoms were lower in the intervention group so this is an amazing finding right these are human subjects one is one group of subjects is doing this breathing protocol the other group of subjects is just meditating they both sets of subjects have been injected with E coli so you know everyone's getting the same amount placed into their system this is very very interesting and it leads to the question that every good scientist two year old or health information seeker asks which is why how how in the world is this work why does this work well to make a long story short ish because I am going to go into depth here the reason it works is because the sympathetic nervous system the so-called stress part of our nervous system it's not really called that but the part of our nervous system that triggers stress from mild stress to severe stress even to panic causes the release of adrenaline and epinephrine in the brain and body and under normal circumstances when we have some sort of invading infection our body is able to push back on that to resist it by engaging the stress response so what's happening here is there's a there's a behavioral protocol involving the nervous system because all behaviors are generated from the nervous system of course a behavioral protocol that people are deliberately employing that allows them to activate the sympathetic nervous system which in turn allows them to activate the normal pathways by which immune system function is enhanced now the reason I'm underscoring this is that the common interpretation of this study is that somehow it blocks the normal immune response but that's not really what's happening here yes there's a reduction in inflammatory cytokines and there's an increase in anti-inflammatory cytokines but that's not really the same thing as blocking the immune response this could just as easily be viewed as enhancing the immune response and combating the intruder in this case E. coli so let's parse this study a little bit more closely first of all what is this magical pattern of breathing some of you may recognize this as so called Vimhoff breathing Vim of course the Dutchman I think his occupation online used to be listed as dare devil believe it or not on Wikipedia that's a pretty cool occupation Vim is best known for his activities with cold exposure he holds multiple world records for that swimming under icebergs and other incredible feats that you definitely don't want to try unless you're extremely skilled and really know what you're doing as he does also for the use of breath work that breathing that is so called Vimhoff breathing is very similar not exactly the same but very similar to tumble breathing as it's been described historically in the science and physiology community and in my laboratory because I run a university laboratory referred to it as sick like hyperventilation which just means repeated deep breaths in and out and then there these retention so I'm because I'm here in the hot sea anyway I might as well demonstrate it for you so you know what this looks like there are variations on this so with respect to Vim with respect to tumble practitioners with respect to the cyclic hyperventilators everywhere this is one general theme of it it involves 20 to 30 deep inhales and then exhale through the mouth followed by a exhale of all ones air and a breath hold that's the retention and then at some point 15 to 60 seconds later repeating the 25 or 30 breaths and then again a breath hold with lungs empty there are variations on this but in our laboratory and in this particular study it looks something like this okay I'm not going to do the whole thing right now but it goes something like this okay so let's assume I did that for 30 30 breaths I can all right feel myself perspiring a little bit you're heating up that's the release of adrenaline it's caused by that breathing pattern and then exhaling all of ones air no speaking between like I'm doing and then sitting lungs empty until one feels the impulse to breathe and then repeating for several rounds two or three or even four rounds now some people will also introduce a big inhale and breath hold at the end and find that indeed they can hold their breath much longer than they normally would be able to because the trigger to breathe is normally activated by increases in carbon dioxide in our blood we have neurons in our brain stem and in our various regions of our brain actually that respond to when carbon dioxide is too high and trigger the reflex to breathe but when we exhale the deeply we blow off a lot of carbon dioxide so we don't feel that impulse to breathe come quite as soon basically this study looked at people doing these hypervent cyclic hyperventilation with retention 25 or 30 breaths then the retention 25 or 30 breaths then retention 25 or 30 breaths then the retention so three rounds of 25 to 30 breaths followed by exhale hold in between a various duration but in general 15 to 60 seconds is typical what happened physiologically this is what one of the reasons I like this study what happened physiologically well a couple things course blood oxygenation drops you would expect that based on hyperventilation and especially based on the exhale of so much carbon dioxide we could explain why that is but blood blood blood levels of oxygen drop the pH the alkalinity of the body goes way up this is very interesting if you look up this paper you can look at figure one panel C the pH goes way up people become alkaline you heard for alkaline water I hate to say this I probably lose some friends for this but don't don't waste your money on drinking alcohol alkaline water you can't really shift the alkalinity of your body there are cases where some compartment in your body needs to be more alkaline than the rest your gut is a different alkalinity than other areas of your body etc but ingesting high alkaline water isn't going to shift your overall alkalinity if someone can send me a quality reference that shows different than I'm happy to revise that statement but in any case doing that pattern of breathing that just described greatly increases a pH greatly I I should say doesn't send it off into dangerous levels it takes it from 7.4 to 7.6 which is a significant increase in alkalinity so as pH levels for those you remember high school or college chemistry as as the numbers on the pH go down you're becoming more acidic as they go up your body you're becoming more alkaline okay or more basic so you go from 7 these subjects one from 7.4 to 7.6 during the breathing and then afterwards it returned to normal but that shift in alkalinity is thought to be important here so what's going on here how is the breathing leading to these shifts in or I should say reduction in inflammatory cytokines and an increase in the liberation of these anti-inflammatory cytokines well the authors make some good arguments as to why it's not the shift in pH per se or the shift in carbon dioxide levels in the blood but rather it's the release of epinephrine there's some good reason to believe why that's the case is beyond the scope of this discussion but that it's actually the release of epinephrine a K adrenaline that's causing this reduction in inflammation and that's actually supported by something that you've probably experienced before which is if you've ever worked worked worked worked worked really hard or you've been care caretaker for somebody else or studying for exams and people around here getting sick and you're just powering through it and you're not getting sick but then you stop you turn in your final exam you you stop taking care of somebody else or you finally stop and rest or you go on vacation and then you get sick well you've got the risk of getting sick and you're not getting sick well you've just experienced the effect that adrenaline epinephrine can have in activating your immune system by way of the nervous system in order to keep fighting and combating infection and that brings us to a larger theme which is that stress and combating infection or a wound is not one unique system it's the same stress system that you use to combat psychological stress so when you're very very stressed at least in the short term because you release so much adrenaline and epinephrine you're actually better able to combat infections and you reduce inflammation and the whole feeling lousy response right remember reduced flu like symptoms here so this pattern of breathing is actually a very useful tool and I confess I use this pattern of breathing anytime I am at the initial stages of getting some sort of bug if I feel like I've been running myself ragged or if I somehow for whatever reason have a tickle my throat or I have that kind of sensation in my nose I feel like I'm going to be a little bit more careful that I'm going to be able to do a sensation in my nose like I might have caught a bug of some sort I will do this pattern of breathing I've been doing it consistently gosh for the last four years or more you know now this is just anecdotal reports but I find that it allows me indeed to either have those early symptoms disappear or it allows me to just kind of push through and harder longer I don't suggest people continue to push through exposure to infections obviously don't want to infect other people nor do you want to crash and suddenly get a massive illness of some sort because you stop doing this breathing but I do think it's a useful tool to purely behavioral intervention that has been shown here and now there are additional studies on the way to enhance the function of your immune system and to reduce inflammation and this is to me one of the most concrete examples of a zero cost tool that bridges the activation of the nervous system through breathing with the immune system by way of releasing adrenaline and thereby reducing the terrible effects or feelings of laziness from a in this case in the coli infection now I'd like to focus on a couple of important points that I haven't heard discussed broadly elsewhere which is that the hyperventilation and the breath retention are both important so you can't simply hyperventilate to get this this effect at the level of epinephrine release and reduction in inflammatory cytokines it's been shown before that the hyperventilation phase and the hypoxia which is a low low oxygen saturation due to the breath retention they both combine to increase epinephrine adrenaline levels so you have to do the 25 or 30 breaths and then the retention 25 or 30 breaths and the retention meaning that the exhale with the breath hold in order to get the full effect I also want to provide a critical cautionary note don't do this anywhere near water or while driving a car these things are might seem kind of obvious but obviously in the off chance that you black out or something like that it could be disastrous so please be careful and again don't try and push the breath hold the moment you feel the impulse to breathe just breathe and it did seem that the three rounds of 25 to 30 breaths with interventions excuse me with breath hold retention in between was the ideal protocol there's one last very interesting feature of the study that I want to emphasize and that was that they actually measured the so called catacolamine concentrations catacol amines are things like dopamine epinephrine or epinephrine these are chemicals in your nervous system and body that promotes states of alertness dopamine of course part of the reward and motivation pathways they explored the levels of these molecules in blood in plasma during and after this breathing protocol and as interesting as I mentioned before epinephrine showed robust increases compared to the control group nor epinephrine significant increases occurred in the in the breathing group but in the cyclocopyriventilation retention breathing group of course but less so and dopamine levels actually drop somewhat but this is very interesting because there's a new and emerging literature largely from isa ay ysa rolls lab in Israel what her laboratory has shown is that motivational state and mindset has a powerful impact on various aspects of the immune system that were thought to be independent of the brain and mind and thinking so this brings us back to something that we discussed at the very beginning of this episode which is that you know 20 30 years ago the idea that you could heal the body with the mind was considered kind of quackery I think that there was an intervening period up until now where people might have said sure if you're stressed out it's going to make things worse I mean I think everyone agrees that stress makes every thing worse at some level outcomes to neurodegeneration performance in physical endeavors and mental endeavors if stress is too high for too long people experience different challenges and essentially every major psychiatric disorder everything suffers but in the short term stress can actually be beneficial in the ways that we just described and stress if you we break it down is really a neurochemical state right it's the release of these cataclysmines and what isa rolls is laboratory has shown is that when the so called dopamine system and several episodes I described there multiple dopamine systems but the so called mesolimbic reward pathway involving areas like the nucleus of combs and etc. when the reward system that's associated with dopamine and nor noripinephrine is activated you see incredible effects including for instance highly significant reduction in tumor size in cancers now why would that be what how is it that mindset dopamine and tumors are and tumor growth are somehow linked we now know how this occurs largely through the incredible work of iso rolls and others so now I'd like to turn our focus to how it is specifically that certain mindsets impact the immune system in ways that we can actually point to specific biological pathways and also specific protocols related to mindset this is a simple way to frame all this would be to say that most of us are aware that yes indeed you can worry yourself sick we've been told that you're going to worry yourself sick and actually there was a paper published in science again one of the top three journals out there the top three really being nature science and cell and then other of course excellent journals exist but this was a paper that came out in science last year first author is kataoka kata okay a describing psychogenic stress and fever so this was looking or asking the question are there areas of the brain that actually underlie this notion that we can worry ourselves sick and they discovered a new pathway and they were able to both activate this pathway independent of worry and stress and see illness occur and they were able to inhibit this pathway block activity in this neural pathway and prevent psychogenic fever and the worrying of oneself sick so they they were able to do this in a very controlled way I'll just mention the pathway in case you want to look it up in more detail this is a cortico limbic pathway so for just orientus the cortex is it more or less the outer shell of the brain it's involved in thinking and sensation and perceptions and learning and maintenance of a lot of memories are stored there we all hear that you learn you learn and remember in the hippocampus that's the initial side of learning and memory but then that information believe or not is passed off to the cortex where it's stored in kind of a long long term hard drive type storage so the cortico limbic pathway is one in which your thoughts your prior experiences can literally in a structure way feed down on to the areas of the brain that control very basal processes including temperature regulation so this is a cortico limbic hypothelamic pathway we talked earlier about the hypothalamus is controlling temperature and a lot of sickness related behavior right remember Vegas up to the hypothalamus and all the sleep more less appetite fever okay that's all in the hypothalamus this is a top down cortico limbic hypothelamic pathway and it has a fancy name it's the dorsal pitidunkular cortex dorsal taniatecta the short of that is the dp dt t so let's just call the dp dt t to the dorsal medial hypothalamus not a lot of ds it shouldn't mean anything doesn't really matter what we call it but what's important is conceptually it's a pathway that originates in sites of the brain that are associated with thinking with emotion and with prior history and feeds directly into an area of the brain that's involved in basic physiological subconsciously controlled processes so that's incredible right and it points to a physical pathway by which the way we think about something changes something core about our physiology now in some ways that shouldn't be surprising right if you think about something that excites you your heart rate can increase you think about something that terrifies your heart rate can increase so the idea that thinking controls our physiology is not a new concept at all but somehow human beings we have been challenged with the idea that we could actually think ourselves into being sick but this paper from Katoka shows that if you expose somebody to a psychological stress you can actually activate this pathway and create a fever and how do they do that well you can do this by exposing subjects to a very stressful real event and you cue it through a sociable learning so maybe like my pilot V5s which I love so much you know we could traumatize me to the pilot V5 if I had some horrible experience happened to me while I'm looking at and concentrating on the pilot V5 then you take away the horrible experience you give me the pilot V5 and I start to experience a lot of the symptoms associated with that terrible event they were able to do this using sickness inducing stimuli and so forth they did all the various derivations and identified this pathway that when activated even in the absence of some horrible event could create fever and illness like behavior and so forth and if they blocked certain stations along this neural pathway they could block that effect so this is really concrete evidence proof if you will that there are dedicated pathways in the mammalian brain your brain in mind that allow us to turn thoughts into illness that's kind of a depressing idea what about the inverse what about turning thoughts into health well that's the work of Isarols they explored the well-established psychological phenomenon that when cancer patients or very ill people or people who are suffering from very debilitating injuries when they had or when people had or reported a sense of hope their rates of recovery were much higher it sounds very subjective but what is a sense of hope a sense of hope is a sense of the future a sense of the future is tightly associated with the dopamine system dopamine again being this molecule of reward and motivation and movement but movement and motivation are about things that are beyond the confines of our skin and are about the future and so what they've discovered and through other studies from other groups have discovered is that stimulation of the dopamine pathway either simply by thinking about a future ideally a positive future but thinking about a positive future leads to activation of this so-called mesolimbic reward pathway and could reduce the size of tumors could accelerate wound healing could greatly accelerate the passage from a state of illness to a state of health and well-being so there are many many studies now starting to wick out related to this there's also the idea that augmenting the dopamine system can increase the rate of healing and so there are individuals out there who opt for instance to take things that increase dopamine now obviously drugs of abuse would not be a good idea in this context even though they increase dopamine they lead to big crashes they have addictive properties etc I've talked before on this podcast about things like L-tyrosine take it anywhere from 500 to 750 milligrams can increase dopamine because tyrosine is a dopamine precursor of course things like macuna purines which are L-dopa the immediate precursor to dopamine some of these will lead to somewhat of a crash in certain individuals other people tolerate them a little bit better again you have to talk to your doctor you have to figure out what's right for you if you have bipolar or mania or schizophrenia these things are I would not recommend them at all I'm not recommending them all I'm just mentioning them for potential exploration if it's safe and right for you but the point is this the dopamine system when activated can accelerate healing it can accelerate the recovery from injury of all kinds and that shouldn't come as a mystery or a surprise result to us it's because this reward pathway and the fact that it's related to a sense of the future seems to liberate entire systems within the body that make inflammatory cytokines go down and anti-inflammatory cytokines go up exactly as was demonstrated in the beautiful PNAS study where breathing cyclic hyperventilation was used to increase epinephrine increase nor epinephrine and to augment the catacolamine system so I think that the bridges between these studies are really relevant in one case I'm talking about potentially taking an over the counter compound to increase dopamine to accelerate healing and in another case we're talking about using breathing there's also the use of cold water exposure to increased dopamine I talked about this several episodes ago but it's been shown that cold water immersing oneself in cold water up to the neck or so how cold well it depends on what you can tolerate but uncomfortably cold but not so cold that you become hypothermic but where you it's challenging to get in but you can stay there for you know three to ten minutes or so has been shown to lead to very significant up doubling or more of baseline dopamine levels and epinephrine levels that go on for several hours this may be the basis for why people will do cold showers or ice baths and then get into a sauna so what's called contrast cold cold heat contrast therapy as a way to augment these neurotransmitters today we've been talking about how these neurotransmitters can be used to enhance the function of the immune system and so just keep in mind that anytime you're talking about increasing neurotransmitter levels that can be done pharmacologically through supplementation or they can be done behaviorally through exposure to cold water for instance or it can be done even just simply by breathing in a particular way cyclocyp prevent allation followed by retention the cataclycule means nor adrenaline dopamine and norepinephrine or the bridge of activation for the immune system and the nervous system they are the way that the nervous system calls out to the immune system we have a problem we need to counter this so you can think of them them meaning dopamine epinephrine and norepinephrine as being able to deploy larger amounts of immune cells all the types of immune cells that we talked about at the beginning of the episode okay so thus far we've been discussing how one can prevent getting sick or when when starts to feel ill how one might be able to shorten the course of that infection by ramping up the activity of the immune system but what about when you're already experiencing symptoms the runny nose stuffed up nose congestion headache etc well there are many ways to address that at the symptom level you're probably aware of all the over the counter medications many of which focus on the epinephrine system you know things that are of the suitifed variety prevent or reduce congestion because of the way that they cause release of epinephrine and some of the effects on dilating the bronchioles and dilating the nasal passages and so forth I'm not going to speak to whether or not those are good or bad choices they do have a couple of effects that are not so great for the course of treating the underlying cause first of all they can cause dehydration so you have to make sure that you're hydrating well both fluids and electrolytes and they also can interfere with sleep because as I've talked about in the episodes on sleep one of the hallmarks of deep sleep and in particular REM sleep is that epinephrine adrenaline levels are low this is what allows you to have intense often very emotionally laid in dreams during REM sleep and not act those out and low adrenaline epinephrine during REM sleep is basically a signature a neurochemical signature of the REM sleep state which is so vital for emotional and physical repair and so forth so the fact that they can inhibit sleep the fact that they can cause dehydration the fact that they can make people feel kind of lightheaded and jittery makes them not terrific choices for a number of people there is an interesting alternative choice and when I say alternative I do mean alternative the choice that I'm referring to is spirulina which is actually a form of algae years ago I think when I first heard about spirulina it sounded very much of the kind of 1970s 80s health food store variety seemed really kind of mystical and wacky but actually now there are some really nice studies and some data and also an understanding of the mechanism by which spirulina can have potent effects in reducing what's called rhinitis which is a fancy word for congestion of the nose and inflammation of the nose basically any time you hear the word that includes itis at least if it's in the medical or health context it generally means inflammation of some tissue so rhinitis just being inflammation of the nasal passages but that's one of the most uncomfortable symptoms of any kind of infection so there are two studies I'd like to highlight just very quickly one is the effects of spirulina on allergic rhinitis and the other is a clinical comparison of the efficacy of spirulina platensis that's a technical name and citriter and satirazine for the treatment of allergic rhinitis these looked at humans so this is not a malstudy this is a study on humans both sexes so males and females in one case looking at 100 plus subjects, 129 subjects the other 65 subjects so a decent number of subjects randomized trial, double blind both cases saw significant decreases in nasal obstruction, improved ability to smell, improved sleep, daily working, cytokine, inflammatory cytokines were reduced as well, reduction in nasal itching all the stuff that you'd like to experience I could imagine after taking two grams, two grams, not milligrams but two grams of spirulina sometimes had to be taken for a short while before the effect kicked in so that's pretty impressive I would say but it doesn't really speak to mechanism but in exploring the underlying mechanisms for spirulina's effects on reducing rhinitis it's interesting to find that spirulina actually can inhibit the formation and or activity of so-called histomanurgic mast cells, MAST-T we haven't talked a lot about MAST-T cells but they are in very interesting cell type in the immunosponts essentially what they are little packets of histamine and when we have some sort of injury or irritant rather to the skin so a mosquito bite for instance or poison oak or poison ivy, something that causes an itch or something that causes inflammation internally doesn't just have to be on the skin these MAST cells are these little bubbles that contain histamine that go to that site and release their histomanurgic contents and cause swelling and inflammation of whatever cells are affected locally you might think well why would I want to have a mechanism in my body that would cause swelling and inflammation, well then those cells in turn send outside of kind signals that recruit the very cell types that we were talking about way back to the beginning of the episode the cells that are characteristic of the innate immune system that come in the macrophages and the other types of cells that will come in and gobble up the foreign invaders or will help sequester and move away say the poison from a bite or from whatever irritant again it doesn't just have to be at the skin surface I'm describing an example of at the skin for instance if you've ever had hives of any kind that almost certainly involved MAST cells so when you take an anti histamine in order to deal with seasonal allergies for instance you're dealing you're excuse me you're taking a compound that's reducing histamines in MAST cells and spirulina has also been used quite effectively as a way to treat seasonal allergies and some of the symptomology equally on par with some of the major prescription and over the counter drugs for that one cautionary note spirulina does can carry some side effects for people that have a genetic mutation leading to something called PKU these people know who they are they're very sensitive to phenolalanine the same people cannot drink any sort of neutercerida diet soda for reasons that they understand it could be quite dangerous it's a rare genetic disorder but nonetheless spirulina can can be an issue for those people for most people the side effect for profile is pretty minimal and just to be clear I don't have any relationship to spirulina company or anything I just find interesting that there are these compounds that sound rather forgive the phrase but rather new AG because they come from a algae from a plant but when you look at the underlying mechanism it makes perfect sense so that's often what we like to point out here is that if there are these so-called alternative therapies alternative because most people haven't heard of them it's always nice if they map to a specific logical mechanism and framework by which that compound would work as opposed to just some anecdote of oh I hear spirulina is great for allergies well now we know why it inhibits mast cells and histamine ergic mast cells in particular earlier I mentioned a new and very exciting study published as a full article in nature full article means that it is a major finding it at the journal nature they have letters which are important findings they're still very high stringency for getting a letter in nature published but the full articles generally there's only one or two per issue in the weekly edition of nature and just last week there is a very exciting article published from Chufu Maz lab at Harvard Medical School Chufu I've known for a number of years his group has done phenomenal work on the mechanisms of itch and pain and discovering some of the receptors and pathways for itch and pain and more recently they've been exploring the mechanistic basis of acupuncture and the title of the article is a neuro anatomical basis for electroacupuncture to drive the vagal adrenal axis and while that's a mouthful now most all of you are probably familiar with what I mean when I say vagal adrenal axis vagal meaning of the vagus and adrenal of the adrenal glands and so perhaps we should not be surprised although excited nonetheless that when Chufu's lab looked at stimulation of the body with so-called electroacupuncture so these are needles where a small bit of electrical current low level of electrical current is passed into the needle and therefore into the body they located sites on the body that can increase inflammation by way of releasing inflammatory cytokines these areas included the abdomen and they found areas on the body such as the lower limbs or the hind limbs in this case that can stimulate the vagal adrenal reflex and can lead to reduced inflammation and what was really interesting is that they figured out that it was activation of nerve endings that resided in the fascia I mentioned earlier what fascia is but just to remind you the fascia is a really thick sheath of tissue that surrounds muscle if ever you've heard of rol thing rol thing is a form of very intense massage I've never had this done but I've heard about this it involves among other things actually separating the muscle away from the fascia somewhat so it's a very very deep tissue massage actually a good friend of mine who had this done told me that it was probably the most challenging experience that physical experience that you'd ever been through going through this rol thing procedure maybe some of you have been roped as they say and can report to the experience whether or not it was pleasant or unpleasant or you felt benefits or not in any case this study isn't about rol thing per se but it is about the fascia and so what they discovered is there's a specific population of neurons those neurons have a name as they often do in science name isn't important but if you want to look it up it's the proc R2 neurons PROK R2 neurons and they send a connection deep into the limb fascia tissue and then they send another connection the connections referring to our axons neurons have axons so a wire in one direction that goes into the deep fascia tissue of the lower limb near the calf and thigh and then they send another wire up into the spinal cord and to a region of the hind brain in the back of your brain near your neck called the medulla in the medulla oblongata that neuron also has a name called the DMZ doesn't matter and that neuron connects to the adrenal gland to release our good old friends the catacol means nor adrenaline adrenaline and dopamine or nor epinephrine epinephrine and dopamine and their release causes a reduction in inflammation even in response to an injection of something called lippy polysaccharide which can actually induce fever so what is all this saying this is saying that activation of the deep fascia tissue causes a chain of neural reactions that leads eventually to the release of nor epinephrine or adrenaline and dopamine and once again lowers inflammation very much like the breathing study that we talked about earlier in the pattern of cyclocypropynalation with retention leading to reductions in inflammation I can't tell you how happy this makes me I had nothing to do with this work but the reason it makes me happy is because I have a particular fondness for when practices that have existed for many centuries or even thousands of years such as acupuncture such as respiration work start to converge with some of the hardcore mechanistic science and the reason this excites me is not because we want to take science and erase the previous tools and methods of these ancient practices not at all and it certainly isn't the case that we just want to name things or rename things with modern science. What's very exciting is when we can discover mechanism that explains why certain practices work first of all that validates those as legitimate practices maybe even insurance will start to cover them whereas maybe they previously had not I don't know what the current status is for insurance coverage of acupuncture maybe I'm guessing there are places that do it maybe others that don't know what I'm doing others that don't I personally am not somebody who receives acupuncture I have in the past but I'm it's not that I'm a particular fan of it but I think that there are a number of people that benefited from it so I think that's wonderful breath work and respiration work is something that I've cultivated as a practice over the years I mentioned earlier how I use it to push back on incoming infections and so forth and now that doesn't sound like total you know like just a figment of my imagination there's actually a mechanism published mechanism to explain it. But the most exciting thing to me about all this is that practices that traditionally have been shrouded in complicated language or were the unique domain of the practitioners and relied on phrases like the meridians or the chakras of which I think is perfectly valid language but doesn't inform mechanism and then in a separate community the community I come from the community of scientists have used language like prop our two neurons medulla oblong out of vagal adrenal axis and basically no one can communicate with one another because the language is shrouding what we're now starting to see is that at their convergence is a common mechanism and with that understanding what's going to be really terrific is as new protocol start to emerge so in understanding mechanisms and pathways and then being able to understand the the base set of practices like breathing like electra acupuncture and so forth we can now start to daydream in a very realistic way about the development of new protocols more effective protocols protocols protocols that perhaps one can do at home without needles perhaps protocols such as the breathing that you can do anywhere any time and and be confident that you're actually impacting the aisle six and the aisle eight pathways reducing those and increasing aisle 10. So we are no longer wandering around in the fog hearing about these magical techniques without understanding why they work nor are we just seeing a bunch of science that is descriptive but not mechanistic or pointing to specific protocols so I'm just delighted again I had nothing to do with this work but I really want to work to work to food and colleagues and and also want to acknowledge a journal as prominent as nature for featuring this up front because I think it really does mark the beginning of a new path in medicine and just to underscore that point a little bit further the national attitudes of health of course has a cancer institute and I institute the deal with trying to combat cancer and to cure blindness and so forth and now they have what's called n c c i h which is complimentary health and so there are good tax dollars being put to the kinds of explorations that we're talking about that undoubtedly are going to lead to better treatments for immunological diseases neurological diseases the convergence of the immune system and the nervous system very exciting times and I hope that by learning about some of this new and emerging science and hearing about some of the protocols that are either zero cost or low cost certainly for respiration that's the case or for the use of heat or cold or maybe even lecture acupuncture if you have access to that that we can really see that we're starting to evolve as a field of health and medicine and science and ancient practices and that they're really starting to converge and have a vector as we say in a new and more exciting once again we've covered a lot of information today we learned about the immune system the adaptive immune system the innate immune system and the nervous system and how those interact and throughout we discuss protocols that can allow you to tap into this relationship between the nervous system and immune system and hopefully avoid and or shorten the course of any illnesses injuries or inflammation that you might encounter if you're enjoying and or learning from this podcast please subscribe to our YouTube channel and also on YouTube please leave us a comment one of the best forms of comments you can give us our suggestions for future topics and future guests to have on the Hubertman Lab podcast please also subscribe to our podcast on Apple and Spotify and on Apple you can also leave us up to a five star review and leave us a comment there as well if you like in addition please check out our sponsors that we mentioned at the beginning of each episode that's the best way to support this podcast and we have a patreon it's patreon.com slash Andrew Hubertman in there you can support the podcast at any level that you like a few times during this episode and in many previous episodes I mentioned supplements not everybody needs to take supplements but many people find benefit from them a key thing if you're going to take supplements is to know that the quality of the supplements that you're taking is very high and that's not always the case with many supplement brands that's why we partnered with Thorn that's THOR and E Thorn supplements are known to be of the very highest quality and the specificity of the ingredients is very high as well meaning what they list on the product is actually what's contained in that bottle they've worked with the Mayo Clinic all the major sports teams so trust is very very high with Thorn products if you'd like to see the supplements that I take you can go to Thorn dot com slash the letter you slash Hubertman and there you can see all the supplements that I take you can get 20% off any of those supplements and if you enter the site through that portal you can get 20% off any of the supplements that Thorn makes that's THOR and E dot com slash the letter you slash Hubertman to see the supplements that I take or get 20% off any of the supplements that Thorn makes if you're not already following Hubertman lab on Instagram please do so there I teach neuroscience and health related topics sometimes but not always overlapping with the content of the podcast we are also Hubertman on Twitter and last but not least thank you for your interest in science