Huberman Lab #4 - How to Defeat Jetlag, Shift Work & Sleeplessness

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Introduction

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. This podcast is separate from my teaching and research roles at Stanford. It is, however, part of my desire to bring zero cost to consumer information about science and science-related tools to the general public. Along those lines, I want to thank today's sponsors of the podcast.

The first sponsor is Athletic Greens. Athletic Greens is a product that I've been using since 2012, long before I launched this podcast, so I'm delighted that they're sponsoring the podcast. Athletic Greens is an all-in-one vitamin mineral probiotic supplement. It's a greens drink that you mix with water. I add lemon juice to mine because I like the way it tastes. And it gets you all the vitamins and minerals you need as well as probiotics and probiotics are important to me because there are a lot of data now showing that gut health is important for the gut brain access, things like mood, immunity, etc. If you want to try Athletic Greens, you can go to athleticgreens.com/huberman and if you do that, they'll send you a year supply of liquid vitamin D3 and K2. Vitamin D3, as many of you probably already know, has been shown to be important for various aspects of immune system function as well as other biological pathways, metabolic function, etc. So once again, if you want to try Athletic Greens, go to athleticgreens.com/huberman and they will send you a year supply of the D3K2.

This podcast is also brought to us by Headspace. Headspace is a meditation app that makes meditation easy. I've been meditating on and off since I was in my teens - with more off than on - mainly because meditation can be hard to stick to. Some people are very good at maintaining a meditation practice. Others not so much. I'm in the latter category. However, I find that when I have something to guide my meditation, such as Headspace, it makes it much easier for me to be consistent about my meditation practice. There is now tons of data out there in quality peer-review journals showing that meditative states can facilitate cognition, recovery of mental function, recovery of physical ability, etc. So there are a lot of reasons to take up a meditation practice. Headspace and the Headspace app makes it easy to learn and maintain a meditation practice. If you want to try Headspace, you can go to headspace.com/specialoffer and if you do that, they will let you try Headspace for an entire month for free. So, zero risk there. That's headspace.com/specialoffer to try Headspace, the meditation app, for one month for free.

Today's podcast episode is about sleep and wakefulness. We are going to discuss jet lag, shift work, babies, kids and the elderly. And we are going to discuss protocols that are backed by science. That means quality peer-reviewed papers published in excellent journals that can support particular tools that you can use to combat things like jet lag, offset some of the negative effects of shift work and make life easier for the new parent, as well as for the newborn child, the adolescent - anyone that wants to sleep better, feel better when they're awake, etc. If you've listened to the previous three episodes of the Huberman Lab podcast, we've been exploring these themes of wakefulness and sleepiness, how to fall asleep, how to stay asleep. And we've been discussing parameters like

light, exercise, temperature, etc. If you've had a chance to listen to those episodes, great. Today's discussion will be even more digestible for you. If you haven't, that's okay. I will provide a little bit of background here or there so that it's not necessary that you have listened to those previous episodes. But if you get a chance to listen to them, please do it. I think it will help you digest the information better. Let's just take a step back for a moment and remind everybody what we're talking about.

We're talking about an endogenous - meaning within us - rhythm that we call the circadian rhythm. The circadian rhythm is a 24-hour rhythm in all sorts of functions. The most prominent one is a rhythm in our feelings of wakefulness and sleepiness. So, believe it or not, the experiment has been done throughout history, not often, but it's been done where people will go down into a cave and will exist in constant darkness for some period of time. There are also cases where people have been in constant light for some period of time. But because people can close their eyes, it's actually easier to do the experiment where you're in constant darkness to address the question of - what is the endogenous, meaning the internal rhythm that we all have? And it turns out we all have this rhythm of about 24 hours - although it's not exactly 24 hours. Meaning every 24 hours, your body temperature goes from low to high and back down to low again. And it takes 24 hours for that to repeat - not 18, not 6, 24 - plus or minus a couple hours. You also have a rhythm in sleepiness and wakefulness that correlates with that. We tend to be sleepy as our temperature is falling, getting lower, and we tend to be more awake or waking when our temperature is increasing. This is a biological fact. It is right down to our DNA. We actually have genes in every single one of our cells that ensure that every cell is on this 24-hour-ish rhythm, close to 24 hours. We have a clock over the roof of our mouth, a group of neurons called the suprachiasmatic nucleus. That clock generates a 24-hour rhythm and that clock is entrained - meaning it is matched to the external light dark cycle, which is, no surprise, 24 hours. Spending the Earth takes 24 hours. So our cells, our organs, our wakefulness, our temperature, but also our metabolism, our immune system, our mood, all of that is tethered to the outside light/dark cycle. If we are living our life in a perfect way where we wake up in the morning and we view sunlight as it crosses the horizon, and then by evening we catch a little sunlight, and then at night we're in complete darkness, we will be more or less perfectly matched to the external or ambient light/dark cycle. Very few of us do that because of these things that we call artificial lights and this other thing that we call life demands. So, today we're going to talk about when we get pulled away from that rhythm. Now, you may immediately be thinking, "Well, I've heard there are night owls and there are morning larks. They're sometimes called, and they're genetic polymorphisms. That's just a fancy name for genetic variations that make some people want to wake up early and other people want to stay up late and teens want to sleep in more." Sure, that's all true. That's all true regardless of what names we give those. However, there's no escaping the fact that human beings are a diurnal species. We were designed, literally, our cells and the circuits of our body were constructed to be awake during the daytime and asleep at night. How do I know that? Well, I wasn't consulted at the design phase, but I'm certain of that because many studies have shown that when we deviate too far from a diurnal schedule and we try and become nocturnal, we can pull it off, but serious health effects, both mental and physical, start to arise. I'm not going to spend much of today talking about all the negative effects of jet lag. I'll talk

a little bit about it or the negative effects of shift work or trying to scare you by telling you about the quite valid data around depression, amnesia, dementia, all the terrible things that happen when you're not sleeping well. Rather, I'd like to focus on what you can do and arm you with tools.
So let's talk about that perfect schedule for a moment and then let's talk about jet lag and what jet lag really represents and how to push back on jet lag, shift your clock faster, and escape some of the severe bad things that can happen with jet lag, including just feeling miserable when you're traveling for work or vacation. So what is the perfect day? What does that look like from a circadian sleep/wakefulness standpoint? I'm about to summarize what I've said in the three previous podcast episodes, as well as now countless Instagram posts. Here's the deal. You basically want to get as much light, ideally sunlight, but as much light into your eyes during the period of each 24-hour cycle when you want to be awake - when you want to be alert. And you want to get as little light into your eyes at the times of that 24-hour cycle when you want to be asleep or drowsy and falling asleep. How much is enough? Well, you don't want to go so high with the light exposure that you damage your eyes because, as many of you have been saying before, the eyes are actually two pieces of your brain, your central nervous system that were extruded out of your skull, and as pieces of the central nervous system, a.k.a. your brain, they will not regenerate. At least right now, the technologies don't exist to regenerate those neurons in humans. You do not want to damage them. So, what is too bright? Well, when it's painful to look at - when you have to blink or close your eyes in order to bear it. So, please don't look at very bright lights so painful that they're likely going to damage your eyes. However, if you get up in the morning and it's still dark out and you want to be awake, you would be wise to turn on artificial lights - in particular, overhead lights for reasons I've discussed previously. But, those overhead lights will optimally trigger the neurons, these melanopsin cells, in the retina that will activate your circadian clock. When the sun comes out, even if there's cloud cover, the sun does come out every day, regardless of where you live, unless you live in a cave. People have said to me, "Well, I live in an area where I can't really see the sun." Well, the sun is there. It might be hiding behind clouds unless it's very, very dark where you live, like Scandinavia in the depths of winter, in which case you might want some artificial light. Get some sunlight in your eyes when you can. Here's the deal with sunlight and artificial light that I have not discussed previously. A lot of photon energy, a high amount of lux, L-U-X, comes through even cloud cover. A good number to shoot for as a rule of thumb is to try and get exposure to at least 100,000 lux before 9am - 10am maybe, but before 9am. Assuming you're waking up sometime between 5 and 8am. Okay, so get 100,000 lux. Now you do not want to repeat. You do not want to stare at a 200,000 lux or a 100,000 lux light. It's very, very bright. The mechanism of circadian clock setting, and this is very important, the mechanism of circadian clock setting involves these neurons in your eye that send electrical signals to this clock above the roof of your mouth. And that system sums - meaning it adds photons. It's a very slow system. So, let's say that I wake up and I look at my computer screen briefly or my phone screen. That's probably 500 to 1,000 lux. If I were to look at that for a full minute, I would get that photon energy transferred into electrical energy of neurons and it would be communicated to my circadian clock. However, the signal that it's morning will not have registered with the circadian clock. Unless I looked at that for 100 minutes or more. So 100,000. Now the problem is if you wake up at 8 o'clock, you're not going to get enough light from artificial light before you reach what's called the circadian dead zone. So you have this opportunity before 9am, maybe

10am to capture enough photons and you have to do it with your eyes. I've discussed why that's important in previous episodes of the podcast. We have to do it with your eyes. There is no extraocular photoreception. This is not about vitamin D in your skin. This is about setting your circadian clock - which is paramount for mental and physical health. So here we're talking about trying to get that at least 100,000 photons, but not all at once - but you got to get them before 9am ish, maybe 10am. So what do you do? You go outside. If you want to get nerdy about this, quantitative, you could download a free app like Light Meter and take a look around your house with Light Meter and you'll notice that even bright overhead lights are only emitting about 4000 or 5000 lux. It's going to take a long while of looking at those lights with eyes open in order to set your circadian clock and tell your brain and body that's morning. Going outside, even on a cloudy day, could be 7000, 10,000 lux. It's really remarkable how bright it is - meaning how much photon energy is coming through. So try and get 100,000 lux before that 9am. Now, if you can't do that because you live in an area of the world where it's just not bright enough - some people have sent me pictures from Northern England. It's just not bright enough in winter. Then, sure, you can resort to using artificial lights in order to get enough photons. And I'm putting out this 100,000 lux number as a target to get each day before 9am. You can, in theory, get it all from artificial lights, but there are some special qualities about sunlight that make sunlight the better stimulus. First of all, it's free - if it's available outside. There is a number of different - there are, excuse me - a number of different technologies - kind of like this one - like a light pad that - this one says it's 930 lux. I'm not - I'm covering this up because I'm not trying to promote any specific products. I actually bought this just with my own money on Amazon. They're not a sponsor. And it lets you toggle the brightness, I think, by holding this on - holding down this button. You can make it dimmer, brighter. There's about 1,000 lux. It seems really bright, but a cloudy day outside will have five times more photon energy coming through. So, some people set these lights or ring lights that they use for selfies and that kind of thing near their coffee or workstation for a thing in the morning, but you really want to get sunlight. Okay, so those things are kind of nice because they'll travel and we're going to talk about jet lag. But I can't emphasize this enough, that light has to be captured and summed before you enter the circadian dead zone - which is the middle of the day. This is again trying to achieve kind of perfect schedule.

Then I've recommended, based on scientific literature, that you look at sunlight sometime around the time when the sun is setting. And the reason for that, of course, is because it adjusts down the sensitivity of your eyes because here's the diabolical thing. While we need a lot of photon energy early in the day to wake up our system and set our circadian clock and prepare us for a good night's sleep, 14 to 16 hours later, it takes very little photon energy to reset and shift our clock after 8pm. And that's why you want to, as much as you safely can, avoid bright light and even not so bright light between the hours of 10 or 11pm and 4am. A number of people have asked me some questions about this. And the last episode I went into red lights, I would have discussed blue blockers, all that kind of stuff, so I'm not going to repeat all that. But here's the thing, if you see afternoon light, you're going to adjust down the sensitivity of your eyes so that you have a little bit more wiggle room, a little bit more leeway to view lights from screens and overhead lights even late at night without

disrupting your circadian clock. But it is a kind of a double edged sword where you need a lot of light early in the day and you need to avoid bright lights later in the day.

I've mentioned studies on here, a number of you have asked about getting the references. We are in the process of trying to get a webpage going with full links. There's some copyright issues that we have to deal with. But wherever possible, I'll try and reference these studies and when people ask out, generally put them in the response to their comments on YouTube or Instagram.
There have been two studies done from the University of Colorado, both published in Current Biology. You can easily find these online by just googling the words "Current Biology", "camping", and "reset circadian clocks" that have shown that two days of waking up with the sun and avoiding light at night - they actually took graduate students camping. a cool experiment to be a part of - reset the melatonin and cortisol rhythms for these people that had otherwise drifted quite far from their natural rhythms. There are other things that you can do to shift your clock and to reinforce your clock - like exercising more or less the same time - eating more or less the same time, etc. That's not what today's episode is about. So, I just described perfect schedule. Get at least 100,000 lux of light exposure to the eyes - not all at once, but summing across the morning. Again, you know when it's too much because it's painful to look at. So, that's obviously something to avoid. But then, once the middle of the day - let's say you're waking up at 10 or 11, you go outside the sun's overhead, forget it. You're not going to shift your clock. You're just not. It doesn't work that way. In the evening, you see the evening light and you want to get that light to adjust down your retinal sensitivity to afford you a bit of a buffer so that late at night, if you happen to look at screens or go to the bathroom in the middle of the night, it's not going to shift your clock. Because it takes probably only about 1,000 to 1,500 lux of light energy to shift your clock in the middle of the night.

So, let's talk about shifting clocks because for the jet lag person, this ability to shift the clock with light temperature, exercise and food is vitally important for getting onto the new local schedule. And there's so much out there about jet lag today. I'm going to dial it down to one very specific parameter that all of you can figure out without any technology or devices and can apply for when you travel for work, or pleasure, or anytime you're jet lagged. And I want to absolutely emphasize that you don't have to travel to get jet lagged. Many of you are jet lagged. You're jet lagged because you're looking at your phone in the middle of the night. You're jet lagged because you're waking up at different times a day. You're jet lagged because your exercise is on a chaotic regime - some days at this time - some days at that time. And if that works for you, great. I want to be really clear that a number of people always say, "Well, I know so-and-so that, you know, only needed 4 hours of sleep." - and - or "They're just fine. They travel to Europe and it's just fine." And there's a lot of individual variability and we're going to talk about the origins of some of that variability. I know people that can eat anything and somehow seem to maintain great lipid profiles and, you know, body weight and fitness ability. And I know some people that they eat one cracker and they sort of dissolve into a puddle of kind of tears, right? Because they think that that's going to throw them off and maybe it does. I don't know. You know, there's a tremendous amount of variability out there. So, this is really about optimal and what's possible. And you have to ask. I can just say from personal experience, I suffer terribly from jet lag traveling in certain directions, but not others. Some people don't have

trouble with jet lag. Many people will travel to a new location. They feel great for the first day and night and then they crash and they have trouble sleeping. Or they travel back and they have a terrible time getting back onto a normal schedule. And some of this varies with age and some of it varies with genetics and there is no simple pill or anything that you can take to just get rid of jet lag. It doesn't work that way. If it worked that way, I would tell you. But there are some simple things that you can do. I'm going to arm you with the knowledge of what jet lag is and how it works. And contrary to what many people out there say and believe, I know that understanding mechanism affords you more flexibility. Why understand mechanism is just opposed to me just writing up a PDF and giving you a list of things to do? Well, what happens when you can't do those things in exactly the way they're written down? When you understand mechanism, you understand how to control the machine that is your biological system - your nervous system. So, a little bit of understanding about mechanism goes a really long way. So, that's where we're headed.

Let's talk about what jet lag is. Okay, well, I promised that I wouldn't get too dark with all the terrible things that can happen with jet lag, but I'm about to get dark. There are quality peer-reviewed papers showing that jet lag will shorten your life. It will kill you earlier. I guess it means you'll die earlier. It doesn't actually kill you necessarily. Although, there are many cases where tourists end up stepping in front of buses - especially in countries where the cars and buses drive on the opposite side of the street that they're used to - who are jet lagged and lose their life that way. Jet lag is a serious thing. I actually had family story about this. When I was growing up, I had a family member travel overseas for work and take a sleeping pill. I won't name the sleeping pill. Although at the end, I'm going to talk about sleeping pills and had a case of total amnesia for a week. That's not entirely uncommon. If you've ever been really jet lagged and fallen asleep - doesn't even have to be in the middle of the day - woken up - you might not know where you are. That's because time and space are really linked and the brain wasn't designed to be transported four, five, six hours into a new time zone. It just wasn't. Our brain and the biological mechanisms that govern circadian timing were designed to be shifted by a couple hours, not necessarily six or nine or twelve hours. You really mess yourself up. I've had that experience. I usually experience it as fluctuations in mood. I flew twelve hours out of phase to Abu Dhabi once to give a talk at NYU Abu Dhabi. And it was a mess. I actually was getting vertigo. I wasn't hallucinating, but I was really out of it. And my mood was just all over the place. It was very bizarre. Jet lag, even if you don't experience it as mood shifts or amnesia, it can shorten your life. Now, here's what's interesting. Traveling westward on the globe is always easier than traveling eastward, okay? It's interesting because the effects of jet lag on longevity have shown that traveling east takes more years off your life than traveling west. Now, of course, traveling 30 minutes into a new time zone or 3 hours, just one time zone over - or two time zone over, rather - is far less detrimental to your biology and psychology than a 8-hour shift or a 9-hour shift. Now, here's what's interesting. When we think about the effects of jet lag on longevity or this idea that it can shorten our lives, we have to ask ourselves why. Why is that? And it turns out there's a pretty simple explanation for this. We've talked before about the autonomic nervous system - this set of neurons in our spinal cord and body and brain that regulate our wakefulness and our sleepiness. Turns out that human beings, and probably most species, are better able to activate and stay alert than they are to shut down their nervous system and go to sleep on demand. So, if

you really have to push and you really have to stay awake, you can do it. You can stay up later. But falling asleep earlier is harder. And that's why traveling east has a number of different features associated with it that because you're traveling east, you're trying to go to bed earlier. You know, as a Californian, if I go to New York City, I've got to get to bed 3 hours early and wake up 3 hours early, much harder than coming back to California and just staying up a few more hours. And this probably has roots in evolutionary adaptation where under conditions where we need to suddenly gather up and go, or forage for food, or fight or do any number of different things that we can push ourselves through the release of adrenaline and epinephrine to stay awake. Whereas being able to slow down and deliberately fall asleep is actually much harder to do. So, there's an asymmetry to our autonomic nervous system that plays out in the asymmetry of jet lag. So, if you want to read up on this because people have asked me about papers. You can look - there's a paper published by Davidson and colleagues - 2006 - in Current Biology - that talks about the differences in lifespan for frequent eastward versus westward versus no travel, and longevity and etc - a number of different biological markers of longevity. So, going east is harder because going to sleep earlier is harder - if you're trying to do that on demand. Many people have turned to melatonin as a way to try and induce sleepiness. I'm going to talk about melatonin at the end. I've mentioned on previous podcasts. A number of you have asked for the evidence that melatonin is potentially detrimental to some hormone systems. Melatonin is a hormone.And I'll discuss that at the end - in particular the role of melatonin in suppressing a hormone pathway that involves luteinizing hormone - testosterone in men and estrogen in females - as well as a really interesting peptide called kisspeptin. That's a cool name.

Alright, well let's think about travel and what happens. Let's say you're not going eastward or westward, but you're going north or south. So, if you go from, for instance, Washington D.C. to Santiago, Chile or you go from Tel Aviv, Israel to Cape Town, South Africa - you're just going north and south, right? And not either direction. You're not really moving into a different time zone. You're not shifting. So, you will experience travel fatigue. It turns out that jet lag has two elements, travel fatigue and time zone jet lag. Time zone jet lag is simply the inability of local sunlight and local darkness to match to your internal rhythm - this endogenous rhythm that you have. So, before we get too complicated and too down in the weeds about this, I want to just throw out a couple important things. First of all, I mentioned this earlier, but some people suffer from jet lag a lot. Other people not so much. Most people experience worse jet lag as they get older. There are reasons for that. Because early in life, patterns of melatonin release are very stable and flat and very high actually in children. It's one of the reasons why they don't undergo puberty. Then it becomes cyclic during puberty - meaning it comes on once every 24 hours and turns off once every 24 hours. It cycles - cyclic. And then, as we get older, the cycles get more disrupted and we become more vulnerable to even small changes in schedule, etc. - meal times. So, jet lag gets worse as we age. In addition, there are other things that happen with age - that people start doing less exercise, their digestion can get worse, etc. So, some of the effects of age might not be direct effects of getting older, but some of the things that are correlated with being older. Like, people who are willing to have a regular exercise regime can use that exercise regime to shift their circadian clock. And I have a good friend, his father's in his 80s, he's still pushing out 25, 30 push-ups each morning.

He's on the Peloton, or whatever it is, doing a lot of cycling. So, some 80-year-olds are doing that. Many are not. Many 30 year olds are not. But, if you have a regular exercise program, that's going to make it easier to shift your circadian clock for a sake of jet lag. And it's actually a knob you can turn and you can leverage for shifting your clock. Before we go any further, I want to make changing your internal rhythm really easy. Or at least as easy and as simple as one could possibly make it, I believe. What I want to talk about is perhaps one of the most important things to know about your body and brain, which is called your temperature minimum. Most of you know your approximate weight, some of you even know your blood pressure, some of you might even know your body mass index. Some of you might know other things about your biology that have fancy names. But everyone should know their temperature minimum. Your temperature minimum doesn't require a thermometer to measure - although you could measure it. Your temperature minimum is the point in every 24-hour cycle when your temperature is lowest. Now, how do you measure that without a thermometer? It tends to fall 90 minutes to 2 hours before your average waking time. So, I want to repeat that. Your temperature minimum tends to fall 90 minutes to two hours before your average waking time. So let's say you're not traveling and your typical wake up time is 5:30 am, your temperature minimum is very likely 3:30am or 4am. If you want, if any of you want to, you can measure your temperature minimum. You can get a thermometer and you can measure your temperature every couple hours for 24 hours. You can find your temperature minimum. What you're going to find is that you have a low point, the temperature minimum, and then your temperature will start to rise. You'll wake up about two hours later. Then your temperature will continue to rise into the afternoon. It will peak - maybe a little trough - sometimes that happens - and then it'll start declining slowly as you approach nighttime. There are things that will disrupt that temperature pattern - saunas, cold baths, intense exercise, etc. Meals tend to have a thermogenic effect that increases temperature slightly - little blips - but the overall cycle, 24-hour cycle of temperature, has this pattern. And last time I talked about the seminal work of Joe Takahashi and others who have shown that temperature actually is the signal by which this clock above the roof of your mouth entrains or collectively pushes all the cells and tissues of our body to be on the same schedule. Temperature is the effector. And once you hear that, there should be an immediate, "Oh, of course. Because how else would you get all these different diverse cell types to follow one pattern?" Right? A pancreatic cell does something very different than a - you know - a spleen cell or a neuron. They're all doing different things at different rates. So, the temperature signal can go out and then each one of those can interpret the temperature signal as one unified and consistent theme of their environment. So, temperatures vary from person to person. Some people are 98.6. Some people run a little colder, etc. But you have a low point and you have a high point. Know your temperature minimum. How are you going to figure out this temperature minimum? The temperature minimum can be determined by taking the last three to five wake-up times. So, let's say you wake up 7am, 8am, 3am - alright - happens. Take those, add them together, average them - by adding them up and dividing by the number of days. That'll give you the average. If you're one of these people that wakes up at 3am. and then goes back to sleep and sleeps till 10am, your wake-up time was 10am. If you use an alarm clock, your wake-up time is still when you get up, okay? I know alarm clocks have been kind of demonized, but in my world, being late and missing appointments is also demonized so I use an alarm clock. Many people will wake up at exactly the same time each day. There tends to

be some variation for people. Some people, it's going to vary depending on life circumstances - but average that for 3 to 7 days or so. Take that wake-up time. You can then get an average or sort of typical temperature minimum. Okay, so now you know how to get your temperature minimum. Your temperature minimum is your absolute reference point for shifting your circadian clock - whether or not it's for jet lag or shift work or some other purpose. Here's the deal. If you expose your eyes to bright light in the 4 hours - maybe 5 or 6 - but in the 4 hours after your temperature minimum, your circadian clock will shift so that you will tend to get up earlier and go to sleep earlier in the subsequent days, okay? So, it's called a phase advance - if you'd like to read up on this further. You advance your clock, okay? However, if you view bright light in the 4 to 6 hours before your temperature minimum, you will tend to phase delay your clock. You will tend to wake up later and go to sleep later, okay? I'm going to repeat this because there's so much confusion out there and people talk about circadian time and all this. Find your temperature minimum. I tend to wake up at about 6am - sometimes 6:30am - sometimes 7. It depends a lot on what I was doing the night before, as I'm guessing it does for you. But that means that my temperature minimum is probably somewhere right around 4:30am - which means that if I wake up at 4:30 am and I were to view bright light at 4:35 am, I'm going to advance my clock. I want to go to bed earlier the subsequent night and wake up earlier the subsequent morning. And as I shift my wake up time, my temperature minimum shifts too, right? Because each time we shift our wake up time our temperature minimum shifts - assuming that wake up time shifts more than 30 minutes or an hour, okay? If I were to view bright light in the 4 to 6 hours before 4:30am, guess what? The next night I'm going to want to stay up later and I'm going to want to wake up later the subsequent morning. Your temperature minimum is a reference point, not a temperature reading. Again, if you want to measure your temperature minimum and figure out what it is - 98. whatever - a 96. whatever. That's fine. You can do that. But that information won't help you. What you need to know is what time your body temperature is lowest and understand that in the 4 hours or so just after that time, viewing light will advance your clock to make you want to get up earlier. And the 4 hours before your temperature minimum, viewing light will make you want to stay up later. Now some people might be saying, "Well, I wake up early and I want to stay up late and I'm sleepy all day and I'm a mess." Or, "I feel fine." Look, let's talk about feeling fine. Turns out the definition of insomnia is when you're experiencing excessive sleepiness during the day. Sleepiness and fatigue are different. So, in the world of sleep medicine, fatigue is a physical exhaustion. Sleepiness is falling asleep - like falling asleep at your desk or falling asleep during lectures. There seems to be something special about my lectures that makes people want to fall asleep. So, if this cures your insomnia, fantastic. However, in all seriousness, sleepiness during the daytime - unless it's around your temperature peak and only lasts about 90 minutes or so - is a sign of insomnia. It's a sign of lack of sleep. I want to be very, very clear that if you know your temperature minimum, you can shift your clock using light.

You can also shift your clock by engaging in exercise in the 4 hours after your temperature minimum to wake up earlier on subsequent nights or exercise before then to delay your clock, okay? So, now you can start to see and understand the logic of this system. And we'll talk about why this works and the underlying biology, but understanding that temperature is the effector and understanding that you have this low point - that reflects your most sleepy point, essentially - right before waking up. And then temperature rises, you can now start to shift that temperature

according to your travel needs. Here's one way in which you might do that. Let's say I am going to travel to Europe, which is nine hours ahead, typically, from California. I would want to determine my temperature minimum, which for me is about 4:30am - maybe 5am - and I would want to start getting up at about 5:30am, and getting some bright light exposure - presumably from artificial sources, because the sunlight isn't going to be out at that time - maybe even exercising as well - maybe even eating a meal at that time if that's in your practice. You would want to start doing that 2 or 3 days before travel, because once you land in - or I land in Europe - chances are just viewing the sunrise or sunset in Europe is not going to allow me to shift my circadian clock. Some people say, "Get sunlight in your eyes when you land." But, that's not going to work because one of two things is likely to happen. With a 9-hour shift like that, either I'm going to view sunlight at a time that corresponds to the circadian dead zone - the time in which my circadian clock can't be shifted - or I'm going to end up viewing sunlight at a time that corresponds to the 4 to 6-hour window before my temperature minimum. It's going to shift me in exactly the opposite direction that I want to go. So, it can be very, very challenging for people to adjust to jet lag. So, you need to ask, "Am I traveling east? Or am I traveling west? Am I trying to advance my clock or delay my clock?" Remember, viewing light, exercise, and eating in the 4 to 6 hours before your temperature minimum will delay your clock. Eating, viewing sunlight, and exercising - you don't have to do all three, but some combination of those - in the 4 to 6 hours after your temperature minimum will advance your clock. This is a powerful mechanism by which you can shift your clock anywhere from 1 to 3 hours per day - which is remarkable. That means your temperature minimum is going to shift out as much as 3 hours. Which can make it such that you can travel all the way to Europe - and as long as you've prepared for a day or so by doing what I described back home - and then, doing it when you arrive, you can potentially do - accomplish the entire shift within anywhere from 24 to 36 hours. And this is really important to emphasize that once you arrive in your new location - and here I'm talking about traveling eastward California to Europe - once you arrive in your new location, you have to keep track of what your temperature minimum was back home and how it's being shifted during your trip. Now, it's much easier to do than you think. One of the unfortunate consequences of the smartphone is that you can't do something goofy like wearing two watches, one watch that corresponds to the time back home and another one that corresponds to the local time. Typically, it updates automatically based on Wi-Fi, etc. But, if you can keep track of the time back home, then you can easily shift your clock going forward. I'm hoping this makes sense. I really want to emphasize that you don't have to be precise down to the minute. Some of you may be asking, "Well, what about you've got this temperature minimum, and if I view light one minute before it, then I'm going to delay my clock, and one minute after it, I'm going to advance my clock." It doesn't quite work like that, okay? But it's very important to understand that light is the primary way in which we can shift our clock. And now, you should also be able to understand things like the circadian dead zone from about 9:30, 10 am - all the way until 6 hours before your temperature minimum - you're not going to shift your clock. Nothing that you do in that time - in terms of light viewing behavior, feeding, etc. - is going to shift your clock. And so a lot of people are landing in Europe, getting sunlight in their eyes, and throwing their clock out of whack - or not shifting their clock at all. This brings me to the other thing that's highly recommended. And I've mentioned this before, but you want to eat on the local meal schedule. If it's in your practice to fast - fast. That's fine. But when

you eat, you want to eat within the local schedule for alertness. Okay. That means if you arrive in everyone's eating breakfast and you can't stomach the idea of breakfast in your new location, because your appetite is in there - that means the clock in your liver - you have a clock in your liver - biological clock - has not caught up to the new time zone. You can force yourself to eat, if you like, or you can skip that meal. But, what you don't want to do is stay on your home meal schedule - waking up in the middle of the night and eating. That is really going to throw things off, because a lot of the clocks in the periphery - like from the liver - the peripheral body - will send information back to the brain. And then, the brain is getting really conflicted signals. So, the temperature minimum is really your anchor point for shifting your clock best. I don't know why this information really hasn't made it into the popular sphere quite so much. There's all sorts of stuff about taking things like melatonin, using binaural beats - a lot of kind of like more sophisticated, complicated, and potentially problematic ways of trying to shift the clock.

Let's talk about melatonin, but first I just want to pause and shift gears a little bit, because I talked about traveling eastward, but we haven't talked about traveling westward, so I want to do that now. Let's say you're traveling from New York to California, or from Europe to California. The challenge there tends to be - how can you stay up late enough? Now, some people are able to do this because as I mentioned earlier, the autonomic nervous system is asymmetrically wired, such that it's easier to stay up late - later than we would naturally want to than it is to go to sleep earlier. So, let's say you land, and it's 4pm, and you're just dying. You're in California - you came from Europe - it's 4pm and you really, really want to go to sleep. That's where the use of things like caffeine, exercise, and sunlight can shift you, right? If it's after your temperature peak, then viewing sunlight around 6pm or 8pm - or artificial light - if there's in sunlight - will help shift you later, right? It's going to delay your clock and you're going to be able to stay up later. The worst thing you can do is take a nap that was intended to last 20 minutes or an hour. I do this routinely and then wake up 4 hours later or you wake up and it's midnight and you can't fall back asleep. You really want to avoid doing that. So, provided it's not excessive amounts, stimulants like caffeine, and coffee or tea can really help you push past that afternoon barrier and get you to sleep more like on the local schedule and eating on the local schedule as well.

A number of people have asked about the use of melatonin to induce sleepiness. Let's think about what melatonin is. Melatonin is this hormone that's released from the pineal gland, which is this gland.

A couple of notes about the pineal because I've been getting a lot of questions about this. I'm probably going to draw some fire for this, but I'd be happy to have a thoughtful, considerate debate with some peer-reviewed papers in front of us. The pineal does make this hallucinogenic molecule called DMT, but in such a minuscule amounts that it is not responsible for the hallucinations you see in sleep and dreaming. Sorry, folks. It's also not responsible for the hallucinations you might see through other approaches to DMT. It's just not. That's not where the DMT comes from. It's infinitesimally small amounts. There are a lot of wacky claims out there about calcification of the pineal and fluoride and this kind of thing. Look, the pineal sits in an area of the brain near the fourth

ventricle where the skull is not terribly far away - although there's some overlying neural tissue - and with age, there's some aggregation of some of the meninges and other things around there that stick to the skull. Young brains don't look like old brains, but there's no calcification of the pineal, alright? You can forget about calcification of the pineal as a problem. I don't know where that whole thing got started, but that's not an issue. Your pineal will churn out melatonin your whole life.

Melatonin induces sleepiness. Melatonin during development is also responsible for timing the secretion of certain hormones that are vitally important for puberty. Does melatonin control the onset of puberty? Not directly, but indirectly. Melatonin inhibits something called gonadotropin-releasing hormone - which is a hormone that's released from your hypothalamus, also roughly above the roof of your mouth. Gonadotropin-releasing hormone is really interesting because it stimulates the release of another hormone called luteinizing hormone, which in females causes estrogen to be released within the ovaries. It's involved in reproductive cycles and in males stimulates testosterone from the sertoli cells of the testes. Melatonin is inhibitory to GnRH (gonadotropin-releasing hormone) and therefore is inhibitory to LH (luteinizing hormone) and therefore is inhibitory to testosterone and estrogen. There's just no two ways about it. There is immense amount of data on the fact that high levels of melatonin in seasonally breeding animals takes the ovaries from nice and robust ovaries that are capable of deploying eggs and this kind of thing and literally shrinking them and making these animals infertile. These are very high levels of melatonin in seasonal breeders in winter. Melatonin in males of seasonal breeders takes the testes and shrinks them. Long ago when I was at UC Berkeley as a master student, I was working on neuroendocrinology and we were working on this hamster species of seasonal breeders. And basically when days are long, which inhibits melatonin, these little Siberian hamsters - as they're called - have testes about the size of sort of typical table grapes - although that's a weird way to put it. When days get shorter and the melatonin signal gets longer because light inhibits melatonin - days get shorter, melatonin gets longer. Those same hamsters would have testes that would involute to the size of about a grain of rice. Now this does not happen in humans in short days. But nonetheless, the melatonin signal really does have a ton of effects on the hormone system. Now, does that mean that if you've been taking melatonin, you've really screwed up your hormones? Not necessarily. Does it mean if a kid has been taking melatonin that's really screwing up their puberty? Not necessarily. And here's why. Melatonin operates on a concentration level. So in a child that's very, very small - that has high levels of melatonin - it actually can inhibit GnRH, LH, testosterone or estrogen - depending on the sex of the child. But as that child grows through other mechanisms - like growth hormone release, etc. - that same amount of melatonin released from the pineal is now diluted over a much larger body. So, the concentration actually goes way, way down, okay? But here's the problem with supplementing melatonin. As I mentioned in the previous episode, concentrations of melatonin in many commercial supplements have been shown to be anywhere from 85% to 400% of what's listed on the bottle. So, when you take melatonin, or a child takes melatonin, oftentimes they are taking super physiological levels of melatonin, which, at least by my read, and the literature says that it could have dramatic effects on timing and course of things like puberty. So, it's not so much that the journals have come out saying, "Oh, taking that melatonin inhibits puberty." It's that no single study has been done with the super physiological levels of

melatonin that are present in a lot of these supplements in developing children. So, melatonin is used widely for inducing sleepiness when you want to fall asleep in the new location that you've arrived, alright? You can't fall asleep. You take melatonin and helps you fall asleep. It does not help you stay asleep. In addition to that, melatonin has been kind of touted as the best way to shift your circadian clock. I'm happy to go on record saying, "Look, if you need melatonin, you can work with a doctor or somebody who really understands circadian and sleep biology. Go for it if that's your thing." But I, as always on this podcast and elsewhere, I have a bias toward behavioral things that you can titrate and control - like exposure to light, exercise, temperature, etc. - that have much bigger margins for safety and certainly don't have these other endocrine effects that we've been thinking about and talking about. So, if you want to take melatonin in the afternoon in order to fall asleep or in the evening, be my guest. That's up to you. Again, you're responsible for your health, not me. But for many people, melatonin is not going to be the best solution. The best solution is going to be to use light and temperature and exercise on either side of the temperature minimum to shift your clock both before your trip and when you land in your new location and your clock starts to shift. Okay, so now you know my opinions about melatonin. Feel free to filter them through your own opinions and experiences with melatonin. And now you also understand what your temperature minimum is and how it represents an important landmark - either side of which - you can use light temperature and exercise to shift your clock. Just to remind you a little bit about temperature - if you want to shift your clock, typically you would do that by you could take a hot shower and then that will have a cooling effect after the hot shower. And if you were to get into a cold shower or an ice bath - if you have access to one, afterwards - there's going to be a thermogenic effect of your body increasing temperature. And if you just think about your natural rhythm back home when everything's stable, you have a nadir - a low point in - which is your temperature minimum and then you have a peak. And you think about when you're doing this hot or cold shower in that rhythm - now you should be able to understand how you're shifting your rhythm. That temperature rhythm is the one that's going to move. I'll give you an example. If I were to wake up in the morning - and let's say I wake up at 6 am - my temperature I know is rising. I've passed my temperature minimum. If I were to get into a hot shower that would then lower my body temperature when I got out. That is not normally what's happening first thing in the morning. And therefore, my clock would very likely get phase delayed. It's going to delay the increase in temperature whereas if I got to a cold shower - something I don't personally like to do - but I've done from time to time - or an ice bath - that's going to then have a rebound increase in body temperature and is going to phase advance my clock. That peak in the afternoon is going to come about an hour earlier. I'm going to want to go to bed earlier later that night. So, you can start to play these games with timing and hot and cold with meals - whether you eat or you don't eat - and with light exposure - whether you view light or you don't view light. Now you can start to see why understanding the core mechanics of a system can really give you the most flexibility because I could spend the next 25 years of my life answering every question about every nuance pattern of travel. "Well, we're going to Sydney, then we're going there. What should I do?" But that's on you. You need to figure out your temperature minimum and your temperature peak - if you like - and then use these parameters to - it gives you flexibility. And that really underscores the most important thing is that when you understand mechanism, it's not about being neurotically attached to a specific protocol. It's the opposite. It gives you power to not be

neurotically attached to a specific protocol. It can give you great confidence and flexibility in being able to shift your body rhythms however you want and then when things get out of whack, you can tuck them right back into place. One thing that's common is that people need to do a quick trip. It's not always that you're going to go - you know - a vacation for two weeks or work someplace else for weeks on end. If your trip is 48 hours or less, stay on your home schedule. This can be tough and it may require scheduling meetings according to your home schedule.

But if you can somehow manage that, the best thing to do would be to stay on your home schedule. Your clock is not going to shift more than a couple hours - even if you do everything correctly in 1 day. So, if I were to travel, say to Europe - I've actually done this. I did a 24-hour trip to Basel, Switzerland, gave a talk and came back. People thought it was crazy, but I had a little bit of travel fatigue. Because remember, there's fatigue from the actual travel experience - the novelty of it - the air is never great on the planes. This was even true before there were mask requirements and things like that. There's the travel fatigue, but you don't throw your clock off. If you stay 48 hours, then you start to shift a little bit. 72, that's when you start running into trouble. The transit time is also important, but I would say if it's 3 days or less, stay on your home schedule as much as you can. And because sunlight isn't under your control - unless there's something about you I don't know - that's when traveling with some sort of bright light - like the light pad that I have down there that I showed earlier - for those of you listening just on audio, it looks like an 8.5" by 11" pad. It's actually not designed for wake up. It's actually designed as a drawing pad. And you can - it emits about a thousand lux of light. And so if you want to travel with something like that, you can use that in your hotel room to wake up when you like. Some people will use nightshades - you know the - not the nightshades that you eat or that some people say you're not supposed to eat. I don't know anything about that. But the eye covers that to keep light out. Those can be very useful on planes and in hotels and so on. So, you can use light and dark and you can travel with your light and dark devices so that you can stay on your home schedule and get most of your light when it would be your normal wake up time back home. And what's kind of nice is if you know when your circadian dead zone is back home - which is generally for most people around 10am to about 3pm - so, basically the rising phase of your temperature - then you can also feel free to be outside without having to wear sunglasses or you don't have to worry about light exposure. But if you know that window before your temperature minimum, that 4 to 6 hour window, that's the time when if you're viewing a lot of light in your new location, you are going to shift your clock pretty considerably. And then, you can come back home and have a terrible time. At the end of graduate school, I went to Australia - a remarkable country - incredible people - incredible wildlife - an amazing time. I came back and it was the first time in my life where I couldn't sleep on a regular schedule. I was sleeping in like hour long increments throughout the day. It was a nightmare. And it took me weeks to get back on target. And the way I was able to do that was exercising consistently at the same time every 24 hours, turning my home into essentially a cave at night - even covering up the windows and then getting as much bright light in my eyes as I possibly could during the day - no sunglasses, etc.
So, it can take some real work if your clock gets thrown out of whack. There's a phenomenon called ICU psychosis, where people that are in the intensive care unit in hospitals actually lose their mind. They - they become psychotic - hallucinations, etc. And it's because of altered circadian cycles. We

know this because they're exposed to these lights and these sounds - people coming in and checking on them. They leave the hospital or in some cases there have been experiments where people are placed near a window where they get some natural light and the psychotic symptoms disappear - presuming there weren't psychotic symptoms beforehand - before they entered the hospital. So, it's pretty dramatic what light can do to the psyche and to the body.

So, let's talk a little bit about a different form of jet lag that requires no planes, no trains, no automobiles - and that's shift work. Shift work is becoming increasingly common. Many of us are shift working even though we don't have to. We're doing work in the middle of the night. We are working in our computers at odd hours - sleeping during the day. A lot of people who are under shelter-in-place type stuff are doing more of this. Kids with the drifting school schedules. Here's a deal with shift work. If there's one rule of thumb for shift work, it's that, if at all possible, you want to stay on the same schedule for at least 14 days - including weekends. Now that should immediately cue the non-shift workers to the importance of not getting too far off track on the weekend - even if you're not a shift worker. So, sleeping in on Sunday is not a good idea. The most important thing about shift work is to stay consistent with your schedule. Now I had a conversation on an Instagram Live with Samer Hattar, who's a neuroscientist at the National Institutes of Mental Health. He's actually the head of the chronobiology unit there. And he was really emphasizing this point. Because shift work where people are doing the so-called swing shift - where they're working 4 days on one shift and 4 days on another - is extremely detrimental to a number of health parameters. It gets the cortisol release from the adrenals really out of whack. And they're these cortisol spikes at various hours of the day. It messes up learning. It really disrupts the dopamine system and well-being. It is a serious, serious problem. So, if you can negotiate with your employer to stay on the same shift for 2 weeks at a time, that's going to be immensely beneficial and will help you offset a lot of the negative effects of shift work. Now I don't presume that all of you are going to be able to do that. Some of you just don't have that level of control. And of course, I want to acknowledge that shift workers are essential - of course, first responders, firefighters, police officers, paramedic, etc. - but also pilots, night nurses, people working on the hospital wards, people picking up trash. This - these night shifts are critical to our functioning as a society, as I'm sure all of you can appreciate. If you're going to work a shift where, let's say you start at 4pm and you end at 2am, then there's some important questions that arise. For instance, should you see light during your shift? Well, this is a matter of personal choice. But ideally you want to view as much light as possible and is safely possible when you need to be alert. So, that would mean from 4pm to 2am and then you would want to sleep. So, using light as a correlate of alertness and using darkness as a correlate of sleepiness - what this means is - see as much light as you safely can during the phase of your day when you want to be awake. So, it's the same thing I said way back at the beginning of this podcast episode. And see as little light as safely possible and allows you to function during the time when you want to be asleep. So, if you're finishing out that 2 am shift, that's when you would want to avoid bright light exposure. You'd want to go home. You'd really want to avoid watching TV if possible. If you need that in order to fall asleep, that would be a case where something like dimming the screen plus blue blockers - if that's in your practice - or you want to do that - would be helpful and then going to sleep. And then, you'll probably wake up late in the afternoon or early afternoon. Some of

you might say, "Wait, Huberman. I thought you don't like blue blockers." I never said I don't like blue blockers. I don't like people wearing blue blockers at the time of day when they want to be alert. And I don't like people asserting that blue blockers can prevent circadian shifts simply because people are wearing them. The brightness of light is what's important. It's not about the blue. So, if you want to wear them - wear them - or just dim the lights or turn the lights off. So, let's say you go to sleep at - you get home after this 4 pm to 2am shift. You maybe eat something, you go to sleep and you wake up and it's noon or 1pm. Should you get light in your eyes? Well, your first assumption based on what I've said previously might be that you're in the circadian dead zone - that you can't because it's noon or 1pm. But you're not in the circadian dead zone because you're somebody who goes to sleep early in the morning at 2am. So, it's not like the circadian dead zone is a strict time of day. It's an internal biological clock. So, what do you need to know? You guessed it. You need to know your temperature minimum. You need to know whether or not your temperature is increasing or decreasing.

And now we can make this whole thing even simpler and just say if your temperature is decreasing, avoid light. If your temperature is increasing, get light. It's that simple. If your temperature is decreasing, avoid light. If your temperature is increasing, get light. The shift worker who works from 4pm until 2am has a temperature rhythm that's very different than mine where I wake up around 6am / 5am and I go to sleep around 11pm. We both have a 24-hour-ish circadian cycle except mine is more aligned to the rise and setting of the sun and theirs is not, right? So, you have to know your internal temperature rhythm. And no, you don't have to walk around with a thermometer wherever taking your temperature. Although it would be great if some of the devices that are out there - you know, people are counting their steps. I think it would be great if people had a circadian body temperature measurement. I'm not involved in any of this device development, but I think it's a real call to arms - pun intended - to have a wristband that would measure temperature and would tell you your temperature minimum when you travel or whatnot. I don't know, maybe some of these devices already do that. But if they don't, they should. It's absolutely absurd to me why we wouldn't have this simple measurement. Very easy to get that kind of information. You don't even need the exact temperature read. All you need to know is the high and low point. So, let's say you're a shift worker who really is nocturnal. You're flipped. Well, you want to stay on that nocturnal schedule. Now that can be very hard on families and social life of all kinds. But the person who is working, say, from, you know, 8pm - like sundown to sunrise - this raises a question. Should they be looking at the sunrise and should they be watching the sunset? Waking up with the sunset, going to sleep with the sunrise? You think, "Well, is that light going to throw them off?" Ah, probably not. It's just actually going to invert what "sunrise" and "sunset" are. When they're waking up in the morning, if they look at the, you know, they get some sunlight in their eyes, they look at the sun and get some bright light from devices or overhead lights in their apartment or home. Well, that's going to tend to wake them up if it's in the evening, right? So, it's, you know, I don't know if I say that clearly, but if in the evening the sun is setting and they're looking at that setting sun, that is the morning sun for that person. And it will wake them up for their night shift - so temperature rising. Then toward morning, what's happening? Okay, well, they're closing out their work shift. You're going home. The sun is rising. Do you look at the rising sun? Well, based on what you now know, your eyes are very sensitive to

resetting of circadian clocks. What will it do at that time? If this were a classroom, I would either cold call on somebody or I'd wait for the person in the audience. It inevitably exists. So temperature is for that person. They've been up for a while. Temperature is falling - not rising. For me, it would be rising, but because I'm not diurnal. I'm awake during the day. For that person, the temperature is falling. And so they view light while temperature is falling. What's it going to do? It's going to phase delay them. It's going to make it harder for them to get to sleep the following night. So, you would say that person should watch the setting sun to help them wake up because they're going to work the night shift. But you probably have sunglasses on or avoid viewing bright light before they go to sleep. So, it's the same thing. They're just on an inverted as a typical person who's diurnal, but they're on an inverted schedule, okay?

So, I'm really trying hard here to make this all really clear. There are kind of two patterns of requests in the world. I'm noticing as I've kind of ventured into this landscape of social media and podcasts. There are people who want to know every detail and want to quantify everything because they want to get exactly right. These are like the graduate students and students that don't want to make a mistake. And to quote my graduate advisor, provided the mistakes are not dangerous - certainly not lethal - you kind of want to make a few little mistakes so that you can adjust, right? You don't want to endanger yourself, but it's actually - you're not going to get things perfect. That's called learning. Learning is when you realize, "I viewed sun this time and then I stayed up and it really messed me up. I'll never do that again." The other category of people seem to want the one-size-fits all - kind of like, "Give me this pill or give me this protocol." And those things generally work, but they don't afford people flexibility. And if there's anything like that, it's this temperature minimum thing that I've been just hammering on again and again and again today because it's something that you own and that you can really use as a key landmark for shifting your clock. I suppose there's a third category, which is people who are - accept that biological systems are actually much more forgiving than the way they're sometimes described. And I'm going to use this as an opportunity editorialized a little bit. You know, there's so much made of sleep debt. Look, there isn't an IRS equivalent for sleep. They're not going to come around and try and collect all the sleep that you didn't get. No one really knows what the consequences are going to be - for you, and for me, and for the next person - for the sleep you didn't get. You can't really recover the sleep you missed out on. But you also don't want to get neurotically attached to a schedule because there's a thing called sleep anxiety and then people have trouble falling asleep and staying asleep.

So, I want to spend a moment on that and go back to a theme that I've said many times before because these tools work - what I called NSDR - non-sleep deep rest. So, this would be hypnosis. I gave you the link, but I'll say it again, reverihealth.com - for clinically tested, research tested free hypnosis, for anxiety, but also for sleep. Those are very beneficial people. NSDR protocols, non-sleep deep rest protocols for things like yoga nidra. I provide some links to those in the caption for episode two. These things really work. Last night, I woke up - I went to bed about 10:30. I woke up at 3 in the morning. I knew I wasn't feeling rested. I did a NSDR protocol. I fell back asleep. I woke up at 6:30, okay? You need to teach your brain and your nervous system how to turn off your thoughts and go to sleep. And ideally you do that without medication unless there's a real need. You

do that through these behavioral protocols. They work because they involve using the body to shift the mind - not trying to just turn off your thoughts in the middle of the night. Now there are periods of life where things are stressful and people are concerned and you will have some struggle getting and staying asleep and there's - that really has to do more with anxiety - which NSDR protocols also can help with. As I always say, do them in the middle of the night if you wake up. And if you want to go back to sleep, do them in the middle of the day to teach your nervous system how to calm down. Or do them first thing in the morning, if you didn't feel you got enough sleep. In other words, do them whenever you have an opportunity to do them because they really can help you learn how to turn on the parasympathetic / calming arm of your autonomic nervous system. There's no other way that I'm aware of to teach your system to slow down and turn off your thoughts and go back to sleep. But these are powerful protocols and there's a lot of research now to support the fact that they can really help. Meditation would be another example. Meditation of - certain kinds of meditation involve focus and alertness. Those are slightly different than meditations that involve lack of focus and attention to say internal states.
I'm going to pause there and then I want to talk about kids and the elderly. In other words, how do we control sleep and circadian rhythms and wakefulness in babies, adolescence, teens, and age folks?

Before we talk about sleep and kids, I want to tell a little story. It's not a joke. Many of you will be relieved that I'm not going to try and tell another joke this episode - which is the relationship between light, skin and pelage color, dopamine, and reproduction / mating. So, many seasonally breeding animals - Siberian hamsters, which I mentioned earlier - rabbits, fox - other animals - change their color of their coat. In the winter, they tend to be a lighter color - sometimes pure white - sometimes with flecks of black or brown. And in the summer, their pelage changes to a color of brown or red - some other vastly different color. That shift is controlled by light and by melatonin. This has an interesting correlate in humans. So, humans obviously have different skin tones - just genetically - because of the amount of melanin in one's skin - depending on genetic background. But of course, sunlight will increase the amount of melanin in the skin, regardless, right? This is suntan, sunburn, etc. - bronzing, whatever. The whole system is wired so that shifts in skin color and shifts in these cells within the eye and melatonin are actually very closely linked. So, here's the story. Many years ago - meaning about 10 years ago - 15 years ago - let's see, it was 20 years ago - forgive me. A guy named Iggy Provencio, who was running his own lab at Uniformed (Army) Services - this is a standard biological laboratory - discovered that there was an opsin in the eye - in the cells of the eye that connect to the rest of the brain - called melanopsin. Melanopsin, as you - many of you now know - is the opsin. It's like a pigment. It absorbs light. It is the opsin that converts light into electrical signals that then set the circadian clock. Iggy discovered melanopsin because it was similar in form to what was in frog melanophores. It was actually in the skin of frogs that allowed those frogs to go from pale white when it was dark for most of the 24-hour cycle to pigmented - green or brown for a frog. So, there's this relationship between the cells in our eye and the pigment cells of our skin and we also know that in long days, there's more breeding. How does that work? Well, that's actually from dopamine triggering increases in testosterone - mainly in males - and estrogen - mainly in females. Although, of course, there's testosterone and estrogen in both sexes.

So, we have this pathway where it's light, increases in melanin, dopamine, and reproduction on the one hand. And lack of light, melatonin decreases in the darkness of skin - less melanin in the skin - or in the case of an animal with fur, white fur - and no reproduction on the other hand. And humans don't actually shift their breeding patterns tremendously from long days and short days - although there are some data that there are some shifts. We also don't radically change our skin color - depending on how much sunlight exposure we have. But the simple way to put this is, when days are long, there's a lot more dopamine, and we feel really good, and there's a lot more breeding and breeding-like behavior. When days are short, there's a lot less dopamine and a lot less breeding behavior because these pathways are very highly conserved. Now, what's interesting is that as we've moved into a modern society where much of our waking days, we are looking at screens - which is fine, because we're getting a lot of light that way, not as much as sunlight. But also at night, we're getting a lot of light from screens. What's happened is all these pathways - melanin in the skin, turnover of skin cells, dopamine, all of this stuff - has become completely disrupted. Now, that's not to say that we should go back to a time in which we didn't use artificial lights. But I think the important thing to realize is that feeling good with getting a lot of light, the relationship to dopamine and melanin in the skin, and the good feelings of getting light also on our skin - provided you're not getting burned or you're not getting excessive UV exposure - those are not just coincidences. Those are hardwired biological mechanisms that exist in everybody, regardless of how light or dark your skin is to begin with. There's another point which is important, which is that the dopamine system - which is this feel-good molecule - is very closely related to the testosterone and estrogen and reproductive cycles. Remember, melatonin inhibits gonadotropin-releasing hormone, luteinizing hormone, and the production of these hormones. And melatonin is the effector. It is the hormone of darkness. So, I just threw a lot of biology at you, and I'm not saying you're like a Siberian hamster - or at least not in ways that I'm aware of. I'm not saying that your pelage color is going to change. Actually, the reason people go gray is because when you're really stressed - did you know this? When you're really stressed, there's an increase in the nerve fibers that release adrenaline to the hair follicle and that activates peroxide groups in the hair follicle that cause the hair to actually go gray or white. So, actually, stress does make your hair gray or white. Aging does it too. That was a brief aside, but for those of you that are interested in the relationship between light and skin tone and all that kind of stuff, I thought you might find it interesting that these cells in your eye are a lot like these skin cells in frogs or in animals that shift their entire color and sometimes metamorphosize. There's some species that literally change shape and the reproductive organs. In fact, if that wasn't weird enough, when I was in graduate school at Berkeley, there was another graduate student studying a species of hermaphroditic mole - those little things that dig. Hermaphroditic mole that would change from having ovaries to testies and back again depending on day length - super cool - super different - and - wild biological mechanism. If you're wondering how those animals reproduce, they actually adjust the numbers of males and females depending on the density of males and females. So, if there are too many males, some of the males turn their testes into ovaries. If they're too many females, they turn their ovaries into testes. They actually are true hermaphroditic animals as opposed to pseudohermaphroditic animals. Okay, let's get back on track.

Let's talk about the animal that most of you care about, which is the human animal - new parents and babies. Alright, as I mentioned earlier, melatonin is not cyclic. It's not cycling in babies. It's more phasic. It's being released at a kind of a constant level. And babies tend to be smaller than adults. They are. And so, those concentrations of melatonin are very high. As a baby grows, those concentrations per unit volume are going to go down. Babies are not born with a typical sleep/wake cycle. And now all the parents are saying, "Tell me something I didn't know." They also have - and I really want to emphasize this - they also have much more sensitive optics of the eye. So, a number of people have asked me, "Should I be exposing my baby to sunlight?" You don't want to avoid sunlight, but their eyes are very sensitive - the optics of their eyes aren't quite developed - so much so that you know when you look at a newborn baby and they kind of look a little glassy eye and they're kind of looking through you or even a young child. A lot of people think that they're seeing you the way that you're seeing them. Hate to break it to you, but if you ever can just Google "visual image of a 1-month-old", the optics of their eyes are so poor that you're a cloudy image. They're not seeing your fine detail. As the optics get better, then they will see you with more and more clarity. But a lot of that is clearing of the lens and some of the other aqueous features of the newborn eye. They don't see very well. But they also don't have such great ways of adjusting to bright light and so babies have a natural aversion to bright light. So, you really want to avoid trying to use sunlight or really bright light in the same way that you would for an adult on a young baby or child. As children get older, however, melatonin does start to become slightly more cyclic - slightly more cycled. And their body temperature rhythms also start to fall into a more regular - not quite 24-hour rhythm. They're more of these ultradian rhythms. So, in an episode - I think it was one or two of the podcasts, or maybe both - we talked about these 90-minute so-called ultradian rhythms - where every 90 minutes babies are going through a cycle of body temperature and some other hormonal features. I mean, there - so much is changing in their system. So, what to do if a child is in sleeping? You can use phases of darkness and phases of light, but they're going to have to be shortened in order to try and encourage sleep when you want the child to sleep. It's not - that - they're just not going to fall into an adult-like regime of a temperature minimum and a temperature maximum. Their temperature minimums and maximums are fluctuating much more quickly and it varies tremendously - actually, there's an interesting literature of whether or not they have siblings, whether or not they're twins, whether or not they're in a nursery environment, whether or not they're alone - hopefully the baby's not alone, but you know what I mean - that they're sleeping alone in a room while you're in the other room . There are a couple of things that seem to help - which is getting the overall environment into a 24-hour schedule. So, having the room slightly colder - obviously you want babies to be nice and cozy - slightly colder when you would like them to be asleep - slightly warmer for the times you would like them to be awake. Babies tend to be - run pretty hot anyway. And obviously you want to be very careful about avoiding all extremes of temperature, cold or hot. So, if they're going through these 90-minute cycles, you're going to have to adjust those 90-minute cycles as well. And then people say, "Well, that's not going to help me at all because how do I deal with the fact that I need to be up every 90 minutes at night?" There are a couple tools that can be helpful. The first one is going to be to try and understand the relationship between calm and deep sleep. So, the autonomic nervous system can put us into states of - you know - panic where that's kind of seesaw of autonomic alertness goes all the way to panic, or it can

be alertness, or it can be alert and calm, right? So, there's a range there. It's a continuum. It can also be that you're in deep sleep. So, the other end of the seesaw is way up, or you're in light sleep, or you're kind of sleepy, or you're just feeling kind of relaxed. Perhaps the most important thing if you're having to map to a baby schedule in order to make sure that they're getting changings, and nursing, etc. - at the appropriate times - is to try and maintain as - if you can't sleep, or you can't sleep continuously - is try and maintain a - your autonomic nervous system in a place where you're not going into heightened states of alertness when you would ideally be sleeping. Now, I realize that this could be translated to try and stay calm while you're sleep deprived, which is very hard for people to do. But this is where the non-sleep, deeprest protocol surface again and can potentially be very beneficial for people to be able to recover - not necessarily sleep - but for them to maintain a certain amount of autonomic regulation. So, what would this look like? This would look like the baby goes down - maybe it's only going to go down for 45 minutes - if you can capture sleep, capture sleep. There are some data showing what's called polyphasic sleep - if you can sleep in 45-minute increments or batches - even if it's spread throughout the day with periods of wakefulness in between - as miserable as that sound - there are actually some adults that have deliberately employed that who don't have children for sake of work productivity. And it does tend to reduce the total overall amount of sleep that you need. It is a very hard schedule for most people to maintain. But if you have a baby, the baby may be throwing you into that kind of schedule anyway. So, if you can get 45-minute sleep while they sleep, great. If you can get another 45 minutes after waking, then they go back down to sleep, great. So, as many phases of sleep as you can get, but if you can't sleep, the data on non-sleep, deep rest type protocols does show - that at least from a neurochemical level - I want to be clear what that means - reset of things like dopamine levels in the basal ganglia, measured by things like positron emission tomography (PET), etc. Those things tend to reset themselves pretty well if you can access these deep-rest states. So, that means not being alert throughout the entire time that the baby is sleeping - trying to sort of mirror the baby's sleep cycle - which can be brutal for certain people - and especially if you're trying to prepare meals and do all these things. So, I do recognize that there are a lot of constraints on parenting - not just mapping on your baby's sleep schedule. As children approach ages 1, 2, 3, 4 - that's when certainly the optics of the eyes have improved. But you don't want to damage the eyes, of course, with very bright light. They are much more sensitive even until they're - kind of - 10, 11 years old. And we'll talk about vision in children in a moment. But trying to get longer and longer batches of sleep through - hopefully not through the use of administering melatonin to the kids, because that's what I talked about before, why that could potentially be detrimental. Talk about that with your doctor. But more so, trying to get longer blocks of sleep that map onto these ultradian cycles. So, it would be better off to get a 3-hour - like two 90-minute cycles - than a 4-hour batch of sleep, because waking up in the middle of those ultradian cycles can just be brutal for parent and kid. So, if one can't get a full 6, or 10, or some kids should even be sleeping 12 hours when they're growing quickly - trying to get batches of sleep - even if they're fractured throughout the 24-hour cycle - that are matched more to these 90 minute cycles - meaning maybe 1 ultradian cycle of 90 minutes, or 2 back-to-back, or 3 back-to-back-to-back. That's going to be better than waking up in the middle of an ultradian cycle. It's just going to set any number of other things in a better direction than were you to try to say just enforce or force a full 8 or 10 hours of sleep. That's at least what the literature shows. Some kids

sleep great through the night starting at a very young age. Others don't. I typically hear from people who are struggling tremendously. They're losing their mind understandably because they're not sleeping. They're kids not sleeping and - or their kid is sleeping for such brief periods. So, in other words, try to access deep calm if you can't sleep. Try and access sleep if you can sleep - even if it's fractured. And then you say, "Well, what about all the sunlight viewing and the exercise stuff?" When sleep is really, really dismantled - meaning it's happening in various times of day or night - that's especially - at those times it's going to be especially important for the parent to get morning and evening sunlight because your circadian clock is going into a tailspin and it basically wants to anchor to something. So, you want to give it two anchors: morning and evening light. So, this is rather different than what I describe for shift work. This is when things are really chaotic and you're just not able to sleep. Similar circumstances can arise if you're taking care of a very sick loved one. You're up all night. Try and stay calm using NSDR protocols. I know it's harder to do then to say. But those protocols are there. They're free. There's research to support them. Try and get sleep whenever you can. But also try to get morning sunlight and evening sunlight in your eyes if you can. And if you can't get that, use artificial light, okay?

What about later life? So, kids now, adolescents - teens - it is true that teens have a tendency to wake up later and go to sleep later. In part, just because they're sleeping a lot more. They're churning out gonadotropin-releasing hormone and luteinizing hormone. Their whole bodies are changing. I don't know whether or not people realize this, but the fastest rate of aging that any of us will ever undergo is puberty. That is the fastest rate of aging. And so there's a huge number of biological processes that are happening during puberty. I'll probably devote a whole episode to puberty. It's this fascinating aspect to the life - life course. But it is an accelerated period of aging. And the circadian clock mechanisms sometimes are very intact and sometimes they're a little dismantled and going through some change. But prioritize the duration of sleep for adolescents and teens. Now, if that means they're sleeping until 2pm and then waking up and then they're up all night. The up all night part can become a problem - especially with all the devices - texting in their rooms or playing video games. Morning and evening sunlight would be ideal. But some kids are just going to sleep through the morning sunlight. However, if you were to measure their temperature, what you would find is that their temperature minimum would come later in the morning. It's not going to be 8am. It's going to be maybe even 10am if they're sleeping until 11 or 12. Or it might be 8am if they're sleeping until 10. Remember, temperature minimum is 2 hours before your average waking time, typically. So, in teens, maximize the total amount of sleep. Try and get regular sunlight either in the morning, or in the evening or both. But if they're sleeping through the morning sunrise, that's probably not as much of an issue. Waking them up and depriving them of sleep is probably worse because their T-min - their temperature minimum - is actually falling later. So, their circadian dead zone is later, etc. So, I think with adolescents and teens, it makes sense to kind of give them a little bit more rope in terms of allowing them some leeway to adjust their own schedule. Some schools are even starting classes later on the basis of some very good biology to support this late shifted rhythm and this extended sleep phase. There are data from Dr. Jamie Zeitzer, Department of Psychiatry and Behavioral Sciences and others at Stanford showing that turning on the lights in the room of a teen before they wake up helps them get more sleep the subsequent night. It also tricks

them into going to sleep a little bit earlier, but it gives them about 45 minutes more of deep sleep. And that's been shown statistically. Total sleep time increases as well. If they're hiding under the covers, that's not going to work. But their eyes don't have to be open. I know a few parents now that are coming in with a flashlight and flashing their kids over their eyelids before they wake up in hopes of getting this to work. Some have told me this is working. That's not part of a standard study. But it does seem to work because - now you should know why. Because if lights getting through the eyelids and it's say 8am and the kid is still asleep and they're going to wake up at 10, you're giving them light just after or around their temperature minimum - which is going to make them want to go to sleep earlier. And in the case of teens, for some reason we don't quite understand - sleep longer - about 45 minutes longer - spend more time in deep sleep. Adults can do this too. If you can persuade someone or put your lights on timer for lights to go on before you wake up. That's really going to help you wake up earlier. If you're starting to hear some themes are really resounding over and over again, that should be reassuring to you. These are core mechanisms. Fortunately, there aren't a thousand different mechanisms.

Now, in the elderly, there's a real tendency to want to go to sleep very early and wake up very early. And people should talk to their physician. There is some evidence that melatonin levels and patterns of melatonin secretion can become a little chaotic in elderly folks. What do I mean by elderly? Well, it's going to differ. Rates of aging differ, right? You see some 65-year-olds that are struggling to move and seem much older than some 65-year-olds that are still hustling around and have tons of energy. There's - there's a lot of variation. Some of it's genetic. Some of it's lifestyle factors. You know, it really varies. Certainly, lifestyle factors can play an important role in rates of aging. I think that the most prominent results from sleep and circadian rhythms in the elderly are, they need to get as much natural light, even if it's through windows. I realize that some elderly folks can't get outside as easily. It's not safe for them to do it. They can't move around as easily. Exercise can come in various forms for people that can't get outside and get a ton of sunlight by jogging or cycling. They're not able to do that. Light through a window in that case - open window ideally - but for temperature reasons, etc.- sometimes the window has to be closed. Getting people near that window and away from artificial light early in the day and away from artificial lights during the night phase can have a tremendous effect. And in the elderly, that's when melatonin might be a viable option. And this should be discussed with a physician, of course. But you're way past the puberty time point. In most cases, people who are in their 70s, and 80s and 90s are not churning out a lot of GnRH and luteinizing hormone to begin with. And that's where struggles with falling asleep and staying asleep - all the same parameters and things we described before still apply - light, exercise, temperature, etc. But that's where melatonin might be of greatest benefit. Again, I'm not pushing melatonin here. But I think for elderly folks who are having trouble falling and staying asleep, that might be worthwhile. There are - and I should also mention that regular schedule for folks that are elderly and natural - as much natural light as safely possible, those are going to be the key levers for adjusting sleep and circadian schedules.

I've mentioned before in previous podcasts other supplements besides melatonin, and some of those supplements are quite good for sleep. I'm not a supplement pusher. I am somebody who takes supplements. I believe in them. Some have worked for me. Some have not worked as well. But I certainly believe in getting the behaviors right - whether or not it's NSDR protocols, viewing natural light, exercise, etc. - hot baths, or cold showers or what have you - behavioral protocols first. There are some supplements that I've mentioned in previous podcasts, but I've seemed to get a lot of questions about. So, I just want to take a couple minutes and just talk about some of the supplements that can be beneficial for helping turning off thinking, accessing deeper sleep, and even being able to compact your sleep schedule into a shorter period of hours - meaning getting by well with less sleep. People take a lot of sleeping pills. I'm not going to tell people not to take sleeping pills. They can be very problematic, habit forming, high side effect incidents in many cases. Some people can handle them just fine. Again, not a physician - don't prescribe anything. I'm a professor. So, I profess a lot of things - some of which are my opinion. Although, if you look at the scientific literature, there's some impressive data around some nonprescription drug type supplements that have fairly high safety margins that you might consider. But you should talk to your doctor always before adding or taking anything out of your health regimes, right? Your health is not my responsibility. It's your responsibility. So, be a stringent filter. Along those lines, one of the most powerful and useful tools that I've mentioned here on many times - and I plan to mention many, many more times - is the website examine.com - which I have no affiliation with. But is a wonderful site that links you to quality peer-reviewed studies on - related to just about any supplement, including some safety warnings - will also tell you what subjects - whether or not it was rats, cats, elderly folks, or kids, a given study was done on - which is important. It can be kind of hard to pull from sites where people are just advertising supplements, right? They usually don't tell you what the study was and - who were these rats? Who were these kids? Etc. There are three supplements that, at least for me, have had a tremendously positive effect on my sleep that some of you might consider. I would say if you're doing everything properly, behaviorally, and you're still having issues, then supplements might be a good thing for you. Or if you are traveling and you want a little bit of extra help in buffering your sleep wakefulness protocols. Some people like to go just to the supplements, though. Like, "What should I take?" I have people in my life that are like, "Just tell me what to take." You know, I'm more of, "Here's what you might want to do or not do." But - and then, think about what you might want to take or not take - but, personal preference and it's free country, so I'm going to do what you like. Magnesium - so, magnesium has been shown to increase the depth of sleep and has been shown to decrease the amount of time that it takes to access sleep - to fall asleep. It comes in various forms. I've talked a bunch of times about magnesium threonate. T-H-R-E-O-N-A-T-E - threonate - which seems to be the more bioavailable form of magnesium. And magnesium threonate - it seems is shuttled preferentially to the brain, where - which is where you want it and it - there are certain transporters. It actually engages the GABA pathway, which tends to turn off certain areas of the forebrain. It allows you to fall asleep. There is a study - if you would like to explore it - since people serious about supplementation might want to explore the study - which is Ates et. al. A-T-E-S. "Dose-dependent absorption profile of different magnesium compounds" - looks to me like a quality peer-reviewed paper. I can put the link in the caption. And it explores all the different forms of magnesium. It does seem like magnesium glycinate can be similar to

magnesium threonate in terms of which tissues it shuttled to. Magnesium ,malate, M-A-L-A-T-E, is preferentially shuttled to the muscle it appears as opposed to the brain. So, it's going to be more of a muscle repair type thing - or restoring magnesium stores in the periphery as opposed to the brain. Magnesium citrate has another name that I won't mention in jest - because magnesium citrate's main effect - at least on me and the people I know - seems to be a laxative effect, as opposed to a cognitive effect. There's also some evidence that magnesium threonate can be neuroprotective. Those data come from quality labs - mostly rodent studies, not human studies. But it's kind of interesting. And again, the safety margins for these things tend to be pretty high. But any time you're going to take something new, you should approach it with caution - especially since magnesium could be involved in heart rhythm and things of that sort. The other supplement that has been very beneficial for me is theanine. So, this is T-H-E-A-N-I-N-E - theanine - T-H-E-A-N-I-N-E. Theanine activates certain GABA pathways which are involved in turning off top-down processing and thinking - making it easier to fall asleep. And Theanine, 100 milligrams to 300 milligrams, has a calming effect. Theanine is now showing up in a number of different energy drinks and even some coffees as a way to try and get people to ingest more of a given type of coffee - because it - the idea is that it would take away the jitters and the anxiety - allowing people to drink more coffee. I'm talking about taking magnesium and theanine 30 to 60 minutes before bedtime - not during the day to quell anxiety but rather, 30 to 60 minutes before bedtime - with or without food for me - it hasn't made a difference. And the combination of those two things has really helped. Theanine for sleepwalkers can be a problem. It does increase the intensity of your dreams. It gives you very vivid dreams. So, for sleepwalkers or people that get night terrors, stay away from theanine is my advice. Magnesium/theanine might be something to explore for those of you that don't have those issues - with the emphasis on "might". And then, I've talked about a compound and last time I talked about the mechanisms of apigenin, which is a derivative of chamomile, A-P-I-G-E-N - which acts as a little bit of a hypnotic by activating chloride channels, hyperpolarized neurons, increases GABA in the brain. Basically, it makes you feel a little sleepy. And chamomile, for those of you that read your - what was it - that - "Peter Rabbit snuck into Mr. McGregor's garden, ate the chamomile, fell asleep. Mr. McGregor came back..." Anyone flashing back to elementary school? Okay, um - there's a story about chamomile having these kind of sedative effects. Apigenin is highly concentrated chamomile - also has anti-estrogenic effects. So, if you want to keep your estrogen up, you might want to be cautious about apigenin. That's where things like examine.com become really useful because you can go to examine, you put in "apigenin" and it'll tell you all the things that it does. And all the things that it does can sometimes include things that you had no idea - like reducing conversion of certain androgens to estrogens - which you might like or you might want to avoid. That's up to you and where you want estrogen levels - depending on who you are and what your life circumstances and goals are. A few other things that can help the transition to sleep are things like 5-HTP, L-tryptophan. I've talked about why I'm not a fan of those for me. They tend to throw me into deep sleep and then I wake up and I can't fall back asleep. So, I don't like to tinker with my serotonin system. I don't like to tinker with my dopamine system for entirely other reasons. But, none of which are particularly concerning. It's just that I find that if I increase my dopamine by taking L-tyrosine in pill form, then I crash really hard the next day. Or, if I take 5-HTP or L-tryptophan, I fall deeply asleep and then I wake up.

But I did mention that there might be ways to make sleep more compact. And so, this is actually a request to you. I had a really interesting experience when I was a postdoc. I went for the first time to an acupuncturist. I know there are varying thoughts and opinions out there about acupuncture. I can't say that I've benefited so much from the acupuncture. There are now quality peer-reviewed studies showing it published in Neurons - Cell Press journal - excellent journal - showing that acupuncture can stimulate some anti-inflammatory compounds - depending on where the acupuncture is done. This is a really good study. This came out last year. I talked about this on Instagram. I may talk about it again. As well as certain acupuncture sites that increase inflammation. So - you know - there - you can get different types of effects. You can't just say acupuncture is great across the board. And I'm assuming that the acupuncturists know which sites are good for increasing inflammation - which ones are good for decreasing inflammation. However, this acupuncturist that I went to gave me these red pills. He sai, "These are minerals for sleep." And it was remarkable. I took the red pills. Isn't that the thing now? "Take the red pill." I don't know what that means because I'm not tuned in. But these red pills look like little M&Ms. I took a couple of them on his suggestion. And I fell deeply asleep in 4 hours. Later, woke up feeling incredibly rested - more rested than I had ever felt in my entire life and I never required more than 4 hours sleep. Unfortunately, acupuncturists moved away. I never figured out what was in those red pills. I didn't get a chance to do the mass spectroscopy. And I still wonder. He said they were minerals. So, somebody out there knows what these red pills are and what this compound is. And it was incredible. And I would love to know what those are. So, if you know, please don't go taking red pills at random to try and recreate this non-experiment - experience of mine. But, please do contact me if you find out or if you're an acupuncturist and you know what these mysterious red pills were because they were pretty awesome.

Once again, I've thrown a tremendous amount of information at you. I hope you will figure out your temperature minimum and start working with that to access the sleep and wakeful cycles that you want to access. I hope that you'll explore NSDR. You might want to explore supplementation if that's your thing. You have now access to a lot of mechanism about sleep and wakefulness. But in keeping with the theme of this podcast where we stay on topic for an entire month or even slightly more, we are not done with sleep and wakefulness. I know this is very different than the typical podcast format where one week gets how to become superhuman. And the next week it's how to - you know - develop growth mindset. And it's kind of all over the place with episode to episode. We are staying on track because I really believe that as we drill deeper and deeper into these mechanisms and you start hearing some of the same themes again and again, you're going to start to develop an intuition and an understanding of how these systems work in you and your particular life circumstances. And my goal is really to eventually become obsolete. It's what my graduate advisor used to call the "Hit By a Bus" principle. She had a somewhat morbid sense of humor and used to be, "Well, if I get hit by a bus tomorrow, what are you going to do without me blabbing at you here?" So, I don't want to get hit by a bus. I plan on living a very long time if I have anything to say about it. But were I get hit by a bus tomorrow, what would you do for your sleep and wakefulness? You can put a comment on YouTube - which I hope you will do. But if I were hit by a bus and killed, then I wouldn't be able to answer your question. So, know your temperature minimum. Understand light in the early part of

the day is valuable. Light when you want to be awake - provided it's not so bright, it's damaging. It's great for you whether or not it comes from screens or sunlight, but sunlight's better. Avoid light in the 4 to 6 hours before your temperature minimum or else you're going to delay your clock unless you're traveling and that's what you want to do, okay? Use temperature. Increase temperature to shift your clock. Decrease temperature to delay your clock, okay? Map out your temperature and understand it. You don't have to know degree by degree across the day. Know your minimum - know your maximum temperature in your 24-hour cycle and you will feel great power through that because then you'll know also about these ultradian cycles - these 90-minute cycles - within which you can do focused work. Don't expect the focus to come early. Expect the focus to come in the middle and then kind of taper off. We talked a little bit about kids, a little bit about elderly, about parenting. We are going to continue. There's going to be more. But now shift workers, travelers, people that are jet lagging themselves at home - you now have levers in place. Information can be powerful. But you have to implement it in ways - obviously safe ways and reasonable ways - but implementing this knowledge in the ways that you trust are safe and reasonable for you is going to be the way that you can develop a bit of a laboratory about yourself. I loathe the term "biohacking". Sorry, biohackers. I don't believe in hacking anything. I believe in understanding mechanism and applying the principles of mechanism for which there are large bodies of quality peer-review data and even a whole center of mass around certain biological principles - like the effects of light and temperature - temperature minimums - that will allow you to shift your biology in the ways that you want it to go - that will allow you to shift your psychology in the ways you want it to go. Next podcast episode, we are going to talk more about a few things. First of all, we're going to answer more of your questions because during office hours I didn't get to all your questions from the previous episode. So, I do read the comments and we're paying attention and figuring out the most common questions. We are going to get to some of the harder topics. Someone came at me. It's always fun when somebody does this. They say, "Well, these are just the kind of basal, low-level questions. What about the big stuff? What about dreaming, and lucid dreaming and consciousness?" Look, I'll talk about that stuff and I'm planning to do that - some of which in the next episode and the following episode, maybe even. But I want to give you data. I want to give you things that are supported by data. So, I will try to speculate as little as possible because this is a podcast about science and science-based tools for everyday life. This is not about me speculating. Many people have speculated about the role of sleep, dreaming and consciousness - fascinating topics and a rather circular argument, frankly. It's been going on for centuries. Someday we'll get there. Right now, we're concentrating on these deep biological mechanisms that make you who you are and allow you to feel certain ways - good or bad - allow you to function physically in certain ways - good or bad - and give you more of a sense of control. That's my goal here.

Conclusion

Many people have quite graciously asked how they can help support the podcast. First of all, thank you. We appreciate the question. You can support the podcast by subscribing to the podcast on YouTube as well as subscribing on Apple or Spotify. And you can also leave us comments and feedback on YouTube and at Apple. That really helps. We hope the feedback would be positive. But nonetheless, leave us feedback - ask questions. We will use those questions to create future

content for the podcast. As well, if you can recommend the podcast to friends and family and other people that you think might find the information of use, that's terrific. And check out our sponsors that we mentioned at the beginning. That's a really great way to help support us and our ability to bring you this information. Along those lines, a lot of people have asked me about supplements and supplement companies. So, up until now, I've been reluctant to recommend specific supplement brands. The supplement industry is kind of a Wild West of different brands - different levels of quality and stringency. It can be very complicated. And what's on the bottle is not always what you're getting. The quality of what you're getting varies from company to company and even from substance to substance - batch to batch. So, I'm pleased to say that I'm partnering with Thorne. Thorne, spelled T-H-O-R-N-E, is a supplement company that works with the Mayo Clinic and with pretty much all the major sports team organizations. And that I know to have the highest levels of stringency in terms of what's in the bottle matches what's listed on the bottle. And in terms of the quality of what they put in those supplements. So, while I mentioned earlier that supplements aren't for everybody, if you're interested in trying some of these supplements, you might want to check out Thorne. If you want to do that, you can go to thorne.com/u/huberman. So, it's thorne.com/com/u/huberman. And if you do that, they'll give you 20% off any of the supplements that you happen to purchase from Thorne. Thanks so much for your time and attention. I really appreciate it. See you next time on the Huberman Lab podcast. And as always, thanks for your interest in science.