

Essentials: Sleep Toolkit for Optimizing Sleep & Sleep-Wake Timing

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Welcome to Huberman Lab Essentials, [music] where we revisit past episodes for the most potent and actionable science-based tools for mental health, physical health, and performance. I'm Andrew Huberman, and I'm a professor of neurobiology and ophthalmology at Stanford School of Medicine. Today, we're talking all about sleep and how to optimize your sleep. Let's consider what the perfect 24-hour cycle would look like. Regardless of when you wake up in the morning, one of the first things that happens is that your body temperature is increasing. And that's just going to happen naturally. That increase in body temperature in turn causes an increase in the release of a hormone called cortisol. Cortisol is often con demonized and considered this bad thing. And indeed, you don't want cortisol to be chronically or consistently elevated throughout the day or night. But you do want cortisol to reach its peak early in the day, right about the time you wake up. One way that you can ensure that that cortisol peak occurs early in the day, right about the time that you wake up, is to view bright light, ideally from sunlight, within the first 30 to 60 minutes after waking. The reason for that is very simple. You want to trigger that cortisol increase to occur very early in your day, and you don't want that cortisol peak to happen later, which is what will happen if you wait to get outside and see sunlight.

The reason for this is that you have a set of neurons, nerve cells in your eye. They're called intrinsically photosensitive melanopsin cells, but you do not need to know that name. Those neurons respond best to bright light and especially right after waking early in the day. They are best able to signal to a set of neurons that reside over the roof of your mouth called the super kisa nucleus which is a cluster of neurons that then sends a huge number of other signals electrical and chemical out to your entire body that triggers that cortisol increase provides a wakeup signal for your brain and body and sets in motion a timer for you to fall asleep later that night. Here's what you do, or at least here's what I do. I wake up in the morning and I want to reach for my phone. But I know that even if I were to crank up the brightness on that phone screen, it's not bright enough to trigger that cortisol spike and for me to be at my most alert and focused throughout the day and to optimize my sleep at night. So, what I do is I get out of bed and I go outside and if it's a bright clear day and the sun is low in the sky or the sun is, you know, starting to get overhead, what we call low solar angle, then I know I'm getting outside at the right time. Especially on cloudy days, you want to get outside and get as much light energy or photons in your eyes. But let's say it's a very clear day and I can see where the sun is. I do not need to stare directly into the sun. So, the way to get this sunlight viewing early in the day is to look toward the sun. Never look at any light, sunlight or otherwise, that's so bright that it's painful to look at because you can damage your eyes. But for this morning sunlight viewing, it's best to not wear sunglasses. That's right, to not wear sunglasses. It is absolutely fine to wear eyelasses or contact lenses, so-called corrective lenses. In fact, those will serve you well in this practice or this tool because they will focus the light onto your neural retina and onto those melanopsin intrinsically photosensitive ganglen cells. This is grounded in the core of our physiology. There are

literally hundreds if not thousands of quality peer-reviewed papers showing that light viewing early in the day is the most powerful stimulus for wakefulness throughout the day and it has a powerful positive impact on your ability to fall and stay asleep at night. So, this is really the foundational power tool for ensuring a great night's sleep and for feeling more awake during the day. If you wake up before the sun is out, you can and probably should flip on artificial lights in your internal home environment or apartment or wherever you happen to live. If your goal is to be awake, right? If you wake up at 4 in the morning and you need to be awake, well, then turn on artificial lights. If you're asking whether or not turning on artificial lights can replace sunlight at those hours. Unfortunately, the answer is no. Unless you have a very special light, we'll talk about what kind of light. The bright artificial lights in your home environment are not, I repeat, are not going to be sufficiently bright to turn on the cortisol mechanism and the other wake up mechanisms that you need early in the day. The diabolical twist, however, is that those lights in your home or apartment or even on your phone are bright enough to disrupt your sleep if you look at them too late at night or in the middle of the night. So, there's this asymmetry in our retinal, our eye biology, and in our brains biology whereby early in the day, right around waking, you need a lot of light, a lot of photons, a lot of light energy. And artificial lights generally just won't accomplish what you need them to accomplish. But at night, even a little bit of artificial light can really mess up your so-called circadian, your 24-hour clocks and all these mechanisms that we're talking about. On cloudy days, you especially need to get outside. I repeat, on cloudy days, overcast days, you especially need to get outside and get sunlight. You just need to get more of it. Now, how much light and how much light viewing do you need? This is going to vary depending on person and place. I mean, literally where you live on Earth, whether or not there's a lot of tree cover, whether or not you're somebody who has sensitive eyes or less sensitive eyes, it's really impossible for me to give an absolute prescriptive, but we can give some general guidelines. In general, on a clear day, meaning no cloud cover or minimal cloud cover, you want to get this sunlight exposure to your eyes for about five minutes or so. Could be 3 minutes one day, could be 7 minutes the next day. about 5 minutes. On a day where there's cloud cover, so the sun is just peeking through the clouds or it's more dense cloud cover, you want to get about 10 minutes of sunlight exposure to your eyes early in the day. And on days that are really densely overcast or maybe even a rainy, you're going to want to get as much as 20 or 30 minutes of sunlight exposure. Just don't try and get this sunlight exposure through a windshield of a car or a window, whether or not it's tinted or otherwise. it takes far too long. It's simply not going to trigger the relevant mechanisms. Now, if you live in a part of the world where it's extremely dark and overcast or the weather won't let you outside or you live in a cave, there are sunlight simulators or daylight simulators that you can purchase. Those are quite expensive in general.

Therefore, I suggest cheaper options that work just as well because they get just as bright. things like ring lights that are sold in order for people to take selfies and this kind of thing. A LED tablet will work pretty well. I actually have one of those and I put it on my desk all morning even though I still get outside and look at sunlight first thing in the morning. Again, also especially I should say on cloudy days.

Many of our listeners live in locations throughout the world where for instance during the winter it gets very very dark. So they can't get sufficient sunlight. But get that morning light, ideally from sunlight, and take into account all the specific points that I've given you here. When you start doing this, you'll notice that your body will start to feel more energized and it will feel more energized more quickly. You'll actually start to notice this mechanism kicking in each day, especially if you're paying attention to your physiology. It's that diffuse, very

bright sunlight, that photon energy that you really want. That's going to set all the rhythms of your brain and body in the proper way. Not just that cortisol peak, but it's going to trigger proper metabolism. It's going to set a timer for you to be able to fall asleep about 16 hours later. It's also going to suppress any melatonin, a hormone that makes you sleepy that happens to be swimming around in your bloodstream at the time you wake up. It does a number of other things too, including interact with the adenosine system and kind of wash out some of the adenosine that might still be residual if you didn't sleep enough. Fundamentally speaking, get that morning sunlight viewing. I promise you will be grateful that you did. It makes everybody feel better, feel more alert, and it will greatly assist with your ability to fall and stay asleep later that night. You will also want to leverage not just light but temperature as a tool. If you are inclined, it would be wise to try and increase your core body temperature a bit more quickly than it would otherwise if you were to just, you know, shuffle around outside, get your sunlight, maybe read a little bit, etc. And there are two main ways you can do that. The first way is to get into cold water of some sort. So this could be a cold shower of anywhere from 1 to 3 minutes. This could be an ice bath if that's your thing. It could be a cold tub or if you own a cold tub uh that's specifically designed for deliberate cold exposure. Get under some cold water. 1 to 3 minutes of cold water exposure will wake you up because of that adrenaline release. And and I want to highlight the and it will serve to increase your core body temperature.

That's right. If you put something cold on the surface of your body, your brain, a little cluster of neurons in the so-called medial preoptic area, act as a thermostat and say, "Ah, the external of my body is cold and therefore I'm going to heat up my core body temperature." So, this is a little bit paradoxical. People think, oh, if you get into cold water or an ice bath, your body temperature is going to drop. And indeed, that's true. If you stay in for a while, but if you just get in for about 1 to 3 minutes or under the cold shower for 1 to 3 minutes, your core body temperature will increase. So, this is great for waking up. And we have exercise. One of the best ways to increase your core body temperature early in the day is to do exercise. I always say the best time to exercise, at least what the research points to, is immediately when you wake up in the morning. It could be a walk. So you can get your sunlight exposure while you're taking a walk first thing in the morning. It could be a light jog. It could be skipping rope. But try and get your core body temperature increased first thing in the morning. And a great way to do that is with a cold water and or with exercise. And again, it doesn't have to be your full-blown workout for the day if you're doing workouts consistently, which I hope everybody is because everybody really should exercise. Right now, you'll notice we're only focused on this early part of the day. And you might be saying, "Wait a second. I thought this was an episode about tools for sleep." Well, everything that we're talking about doing in these first 60 to 90 minutes of the day really set in motion a wave of biological cascades that carry through the entire day and into the evening and into the night and really do serve to optimize sleep. So just hang in there with me. So the next category of tool for use early in the day is caffeine. You do not have to drink caffeine. So what I'm about to describe are ways to leverage caffeine use to optimize sleep and wakefulness if you are comfortable with caffeine.

Caffeine is something that a lot of people consume early in the day. How much depends on your tolerance and there's a lot of individual variability here. Again, caffeine is a denosine antagonist or effectively works as a denosine antagonist and limits sleepiness. And for many people, shifting that caffeine intake from immediately after waking in the morning to 90 to 120 minutes gives them a much longer arc of energy throughout the day and they don't feel the need to drink more caffeine later in the afternoon. If you do drink caffeine later in the

afternoon, really try and limit the total amount or drink decaf. Certainly keep the total amount to less than 100 milligrams if you are interested in getting into the best possible sleep.

And I say this knowing that many people, including myself, can drink a double espresso with 200 milligrams of caffeine or more at 5:00 p.m. or even 6 PM or after dinner and still quote unquote fall asleep fine or still sleep fine. There are more and more papers all the time that point to the fact that caffeine intake late in the day after 4 p.m. that is can really disrupt the architecture of your sleep. So you might think you're sleeping well, but you're not sleeping nearly as well as you could if you avoided caffeine in those afternoon hours. Now, some of you might be doing your main bout of exercise first thing in the morning and you want your caffeine before that bout of exercise. In that case, I say go for it.

I absolutely respect the fact that people have different work schedules, kids schedules, etc. So, if you want to do some or none or all these tools, that's really up to you. I'm just providing them to you in the simplest form that I can possibly provide them. Now, the other lever or tool that you have available to you is food. Not just what you eat, but when you eat. And it turns out that if you eat early in the day, you support a biological clock mechanism that will make you more alert early in the day. That said, many people choose to fast in the early morning hours of the day or in the first part of the day. I'm one such person. I generally don't ingest any food until about 11:00 a.m. or 12:00 noon.

Sometimes I'll have breakfast. If people are meeting for brunch or breakfast, I will have breakfast for social reasons every once in a while, but most of the time I don't eat until about lunchtime. However, some people are really hungry when they wake up in the morning. Just know that if you eat early in the day, you are further triggering an increase in metabolism and in temperature that will make you more alert. So, you don't have to eat early in the day, but you can start to see how these different tools layer together. Sunlight viewing, exercise, cold water, eating, many of them are converging on the same mechanisms. In fact, when you drink caffeine, there's also a small increase in body temperature due to the adrenaline increase that it stimulates.

So all of these things can be layered on top of one another or you can use them individually or think about them individually. Now food is an interesting lever or tool because it's not just about when you eat, but it's also about what you eat. And I've talked a lot about eating for energy and what that means in terms of caloric energy versus neural energy, etc. in previous podcast episodes. We're not going to focus on that now because that's very nuanced.

All that said, if you eat a very large meal, it doesn't matter if you slept terrifically well 10 hours the night before or if you are about to go to sleep or if it's the middle of the afternoon, if your gut is full of food, there's just a large volume of food in your gut, it's going to divert a lot of blood and other critical resources away from other organs of your body, in particular your brain, and you're going to be sleepy after eating a big meal. So this is sort of a duh, but I think oftentimes in the discussions about what to eat for energy, people neglect to consider food volume as a strong parameter or variable in that discussion. So if you eat a huge breakfast, it's likely that you're going to be tired immediately after eating that breakfast, unless of course you exercise very hard prior to that and you metabolize all that food very quickly.

So if you do decide to eat in the first few hours of the morning, just understand that you are setting or you are helping to set a food entrained as it's called circadian clock. Light, temperature, timing of food intake, movement, and exercise. All of these things literally funnel in in a neural sense. They funnel into this thing that we call the circadian clock. and they let that clock, that set of neurons, predict when you are likely to be eating and active and viewing sunlight the next day and the next day and the next day.

So, what all these tools do is they really set up a cascade. Think of it as kind of a wavefront of wakefulness and focus throughout the day. It'll take you through the middle of the day in the afternoon stages we'll talk about in a few minutes, but really they take you to this period that is about 5:00 p.m. until your bedtime. A second critical period in which you need to leverage particular tools in order to get and stay asleep optimally and to be able to sleep through the night. So really, there are three critical periods throughout each 24-hour cycle. And during each of those critical periods, you're going to want to do as many specific things as you can to optimize your wakefulness and focus and mood throughout the day and your sleep at night. The first critical period is the one that we've been talking about up until now. Things like morning sunlight, viewing caffeine, 90 to 120 minutes after waking, exercise, and so on. And it really encompasses the time from which you wake up until about 3 hours after waking. The second critical period is the time throughout the day and afternoon leading into evening. So you may ask, what are the things that you can do throughout the day, the middle of your day and into the afternoon and evening hours that are really going to set you up for the best possible sleep later that night? Well, there are a few dos and there are a few don'ts. First of all, be careful about ingesting too much caffeine throughout the middle of the day. That's kind of an obvious one for the reasons that we talked about earlier. Second of all, if you are a napper, and I raise my hand now for those of you listening, I'm raising my right hand because I love naps. I've always loved naps. Should you nap?

Should you not nap? That's a question that I get asked a lot and that I asked Dr. Matthew Walker when he was a guest on this podcast. Here was his answer. And here's what the data support. It is fine to nap in the afternoon, but don't nap so late in the day or for so long that it disrupts your ability to fall and stay asleep at night for your major sleep bout. I should also say you do not have to nap. It's kind of an interesting phenomenon that happens on these podcasts and on social media where we'll talk about naps and the fact that naps are great and don't make them longer than 90 minutes, but then all the non-nappers get really worried like, "Wait, am I supposed to nap? I don't like naps. I wake up groggy." You do not have to nap. In fact, if you can make it through your whole day without napping, great. More power to you. So, this critical period throughout the day is one in which most people are doing a lot of stuff. They're emailing and picking up kids and they're exercising and they're commuting and doing all sorts of things, taking phone calls and Zooms, etc. But if you can get that period of deep relaxation through a nap or NSDR, that's going to serve you well. Try not to drink too much caffeine, certainly no more than 100 milligrams of caffeine after 4 p.m. if your goal is to fall asleep at a reasonably normal time. And for those of you that exercise in the afternoon, understand that if you exercise very intensely, so this might be weight training or running or some other very intense exercise, typically that's going to further increase your body temperature and it's going to so-called delay your circadian clock.

It's going to make it such that you want to fall asleep a little bit later, maybe even a lot later. So if you're exercising in the afternoon or evening and that's the only time you can exercise or that's the time that you prefer to exercise, great. Just know that you are delaying your circadian clock, you are making it such that you will

naturally want to go to sleep later and wake up later. Contrast that with if you exercise early in the day, say immediately after waking up or in the first 0 to 4 hours after waking. In most cases, that's not going to shift your circadian clock much. This critical period two or second critical period I should say during the middle of the day is a time in which you should be doing certain things and avoiding doing certain things. So that raises the question of whether or not you should also be getting a lot of light in particular sunlight throughout the day.

Now on the face of it you might just think yes you know sunlight's great provided we're not getting a sunburn and we're not staring at the sun and damaging our eyes we should get as much sunlight as we possibly can. However, because light is such a powerful stimulus for controlling the timing of your sleepfulness or sleepiness, I should say, and wakefulness, we might want to be cautious about how much light we are viewing in the afternoon, in particular, in the early evening hours. Well, turns out it's not so straightforward viewing. So, sunlight to the eyes, sunlight in the late afternoon and evening hours. So again, depends on time of year, depends on location that you happen to be in. But getting some sunlight in your eyes for again maybe 5 or 10, maybe 30 minutes depending on how much cloud cover there is. Doing that in the afternoon serves an additional beneficial purpose, which is you inoculate your nervous system against some of the negative effects of bright artificial light or even dim artificial light in the nighttime hours between 10 p.m. and 4:00 a.m., which is really critical period 3. And we'll talk about what to do and what to not do during critical period 3 of every 24-hour cycle. But to make it very clear what I'm saying here, get that morning sunlight in your eyes, but also get some sunlight in your eyes in the late afternoon and evening hours when the sun is at so-called low solar angle, when it starts to descend in the sky. Getting that sunlight in your eyes in the late afternoon and evening signals to that clock that it's evening time and that sleep is coming. It also serves as a second anchor that tells your brain and body, hey, it's evening. The sun is descending. Those yellows and blues and oranges that you see in the evening sunsets, those signal to your brain and body that evening is there and that nighttime is coming. And they're really establishing a second reference point or wavefront of biological signals that are going to optimize your nighttime hours and your transition into really terrific sleep. So now let's talk about what I'm calling critical period three of each 24-hour cycle. So this would be the period of time of late evening. So, it might be 6:00 p.m. for some, depending on when you go to sleep, or 7:00 p.m.

extending into the hours in which you decide to get into bed and go to sleep. And then throughout the night, there are a number of things that you're going to want to do, and there are a number of things that you are going to want to avoid doing in order to optimize your sleep. First of all, you're going to want to avoid bright artificial lights of any color. Once the sun goes down, you would be wise to try and dim the lights in your indoor environment. If you are going to use light at night, and most people do, I would encourage you to use as little artificial light as is required to carry out the activities you need to require safely. If you're watching a television show or you're watching something on your computer, dim that screen way, way down, as dim as possible while still, of course, being able to view what you need to view. That bright light exposure will absolutely quash any melatonin that happens to be circulating in your brain and body. Now, melatonin a lot of people think of as a supplement, but melatonin is naturally released as the evening comes about and into the nighttime hours. It's a hormone that makes you feel sleepy and allows you to fall asleep. So, viewing bright light in the late evening hours and nighttime hours is really not good for your sleep quality and your ability to fall and stay asleep. So, for most people, a simple rule of thumb is going to be avoid bright artificial lights of all colors and in particular overhead bright artificial lights between the hours of 10 p.m. and 4:00 a.m. Use only as much light as is

absolutely necessary in order to carry out the routines and activities you need to carry out safely.

Now, that's light, but as you recall, we also have this tool related to temperature. And you're probably not going to be surprised that the way to leverage temperature in the evening is the exact opposite of the way that you want to leverage temperature early in the day. Early in the day, temperature increases from cold showers or exercise, etc. wake you up. What that means is that taking a cold shower late at night is probably a bad idea. Rather, taking a nice hot bath or a sauna you might think would heat up your body. And indeed, that's what happens if you stay in a very long time. But if you do hot tub or a hot bath or a sauna in the evening and you don't stay in for more than 20 or 30 minutes and you get out, you take maybe a coolish shower or a warm shower, then what happens is there's a compensatory cooling off of your core body temperature for the reasons we discussed earlier and your body temperature will drop by 1 to 3° and it will make it much easier to get into sleep. So if you're somebody that enjoys hot baths, hot showers or hot tubs, evening and nighttime is going to be the best time to do that if your goal is to facilitate sleep. Similarly, you should try and make your sleeping environment pretty cool, if not cold. Now, that doesn't mean you need to be cold while you're asleep. You can get under as many blankets as you need, but it's a good idea to make your sleeping environment cool. In fact, drop the temperature in that sleeping environment by at least 3°. You'll be happy that you did. You're going to want to sleep in a relatively cool or cold sleeping environment and then layer on the blankets as needed to stay asleep. If you lower the temperature in your sleeping environment, so lower the temperature in that room or use a controllable mattress cover that can cool down like eight or something of that sort, it's naturally going to make your sleeping environment cooler. And if you're too warm under the blankets, all you have to do is extend a hand or a foot out from under those blankets. Whereas, if the sleeping environment that you're in is too warm, there's very little you can do to cool off besides push off those blankets. But if the room is too warm, well, what are you going to do? You'd probably have to put your hands into some cool water, take a coolish shower or something for a couple of seconds. That's not very practical. I would be remiss if I didn't touch on alcohol and CBD and THC. Many places, but not all. THC is illegal, although there are medical uses and some places it's um decriminalized. Other places it's legal. Alcohol, of course, is consumed almost as frequently as caffeine is consumed. The sleep that one gets after drinking alcohol is greatly disrupted sleep. THC and alcohol do help some people fall asleep and maybe even stay asleep. The architecture of that sleep is suboptimal compared to the sleep they would get without alcohol or THC in their system. So, I'm not here to tell you what to do or not to do. I'm certainly not um the substance police.

That's not my role. I'm just reporting to you the biology. If your sleep is not restoring you to the extent that you feel it should or if you are regularly relying on a drink or two in order to fall asleep or THC in order to fall asleep that is disrupting your total pattern of sleep. Okay? So you've done everything correctly up until now. You got your morning routine from critical period one. You got your afternoon routine. You saw some sunlight in the afternoon. You avoided caffeine in the eight hours or 10 hours before bedtime.

You're not drinking alcohol. you've cooled down the room, uh you're doing all these things right, you've dim the lights, etc., etc. What else can we do in order to optimize our sleep? I always say behavioral tools first, then look to nutrition, then if necessary, look to supplementation, and then if still necessary, look to prescription drugs, obviously prescribed by a board-certified physician. There are supplements that for most people will greatly improve their ability to fall and stay asleep. And the three main supplements in that category or that kit of sleep

supplements, and I've talked about these before, are magnesium threonate. So, Theanine, apigenin, and theanine.

Theanine. Theanine. You don't necessarily need to take all three. Although many people get a synergistic effect from taking all three. You may not even need to take even one. What I recommend is that if you're already doing all the behavioral tools regularly and you're still having trouble falling asleep and staying asleep, well then you might try one of the supplements within this sleep stack. They do have fairly wide margins for safety. Although I should also say anytime you're going to add or remove something from your supplement protocol, your nutritional program, you definitely want to talk to your physician. I don't just say that to protect us. I say that to protect you.

For most people, the margins of safety on these things are going to be pretty broad. For some people, the dosages of any one or several of the supplements I mentioned will be zero. That is, you won't need them in order to get and stay asleep most nights of your life. For many people, however, taking 145 milligrams of magnesium 3en8ate can be very beneficial. Some people need to go a little higher. Some people need to go a little bit lower. 50 milligrams of apigenin. And again, you could just take the apigenin on its own. And 100 to 400 millig of theanine taken again alone or in combination with the other supplements mentioned in this stack many people find allows them to get really drowsy and fall asleep sleep really deeply and they feel much more refreshed the next day and they don't have a grogginess. About 5% of people report that magnesium 3 and8 really disrupts their gut. It gives them diarrhea or gastric distress in which case don't take it. Now in a slightly different way, many people who can tolerate magnesium 3 and8 or really thrive on magnesium 3 and8 and like epigenin might find that theanine even at the lowest dose of 100 milligrams because again the range is 100 to 400 milligrams that theanine gives them such vivid dreams that they actually find it disruptive or they wake up and in the middle of the night or they find that the sleep that they're getting is kind of anxietyridden because of the intensity of those dreams. So some people might choose to leave theanine out of the sleep stack and just take magnesium 3in8 or rapenine. Again, some people might leave magnesium 3 and8ate out of the sleep stack. All of this is really about finding the supplementation protocol that's ideal for you. I should mention that whether or not you're taking one or two or three of the components of the sleep stack. The ideal time to take those is 30 to 60 minutes before bedtime. That sleep stack can be very beneficial to people. And I do think that it's preferable to melatonin.

First of all, melatonin is a hormone that you indogenously make. The dosages of melatonin that are contained in most commercial products is far far far greater than what we would make indogenously. So, it's really supra physiological. So, that's of concern because melatonin is not just responsible for making us sleepy and fall asleep. It also does things like interacts with other hormone systems, testosterone and estrogen, even in the puberty system in kids. Is taking melatonin every once in a while a problem for adjusting to jet lag, etc.?

Probably not. I would even say no. But taking it chronically over time, especially kids taking it chronically over time, can potentially be problematic. I do want to mention a couple of broad contour tools that will impact your ability to sleep really well on a consistent basis. And the one that impacts the most number of people is weekends. Turns out that most everybody feels the impulse to sleep in on the weekend, especially if they've

been out late the night before. However, the data show that keeping relatively consistent sleep and wake times is really going to enhance the quality and depth of your sleep. So, if you stay out late one night, sure, you might allow yourself to sleep in an extra hour or so, but you should really try to avoid sleeping in longer than an hour beyond your normal wake up time. It would be better to wake up at a consistent time plus or minus an hour and get a nap in the afternoon provided that nap again isn't too long.

Now, a couple of final points and additional tools that I think are going to be useful to everybody in particular people who have young children or are following a shift work schedule or who are experiencing jet lag. Keep in mind jet lag can be due to travel, which is obvious, but jet lag can also be due to getting woken up in the middle of the night, right? Your body doesn't know the difference between flying to a new time zone and getting woken up in the middle of the night. The tool that I'd like to offer you is an understanding of something called temperature minimum.

And I'm going to make this as simple as possible, and I'm confident that everyone can understand this, even if you don't have any science background. Here's the question you need to ask yourself. What is your typical wake up time? If your typical wake up time most days is 7 a.m., well, then your temperature minimum is 5:00 a.m. That's right. Your temperature minimum is not a temperature. It's a time within your 24-hour cycle. Approximately 2 hours before your typical wake up time, your body is at its lowest temperature that it will ever be in the 24-hour cycle.

That's why it's called your temperature minimum. Here's what you need to know about your temperature minimum. If you view bright light, exercise or drink caffeine or all of the above in the two to four hours before your temperature minimum, that will delay your clock. What that means when I say delay your clock is it will make you want to go to sleep later and wake up later the next night. Okay, so let's run this exercise for you, the person waking up at 7 a.m.

on a regular basis. I can predict with almost certainty that your body is going to be at its lowest temperature at 5:00 a.m. So, what that means is that if you get up at 3:00 a.m. or at 4:00 a.m. and you flip on bright lights in your house or in your bathroom or you have a cup of coffee or you do any kind of exercise or you get up and head to the airport, the mechanisms in your brain and body that control timing of sleep and timing of waking will shift. They will delay. It's as if you put your clock on hold for a little while and then let it start again. Okay, that's the simplest way I can describe it. And you will tend to want to go to sleep later and wake up later the following night. Now, the opposite is true if you view bright light, drink caffeine, or exercise or socialize, I should say, in the hours immediately after your temperature minimum. So for you in this example, the person who's waking up at 7:00 a.m., your temperature minimum is 5:00 a.m. If you view bright light, exercise, maybe have a snack, maybe not, or socialize, move about at 5:30 or 6:00 a.m. or 7:00 a.m., that will tend to phase advance your clock. It will tend to basically make you want to go to bed earlier and wake up earlier the following night.

Now, I use this example of a person who wakes up typically at 7:00 a.m. whose temperature minimum is 5:00 a.m. But of course, you need to adjust that for yourself if you're somebody who wakes up at 9:00 a.m. or at 5:00

a.m., etc. Why do I offer this as a tool? Well, this is an immensely powerful tool if, for instance, you are headed to a time zone where you need to go to bed earlier and wake up earlier once you arrive in that time zone. What it means is in the day or two before you leave, you can force yourself to exercise, drink caffeine, maybe even to eat a meal early in the morning, or maybe you still fast early in the morning. That's really up to you.

But you force yourself to do the act the activities that are going to phase advance your clock. Whereas, if you're traveling to a time zone where you are going to need to go to sleep much later and you're going to need to wake up much later, even a little bit later, you can do those things in the hours prior to your temperature minimum. And I should say for everybody, people who are doing jet who are jetlagged and engaged in shift work or not, but just for everybody, if you need to be awake in the middle of your sleep cycle, you know, you're feeding a baby or you're um you're taking care of a loved one or you need to do something that's critical or you need to work, use red light. Okay.

Now, for shift workers who really are trying to stay awake all night and sleep all day, this is not going to be ideal. But for people that for instance need to stay up really late one night or wake up especially early like 3:00 a.m. to prepare for an exam that you're just not ready for or to head to the airport etc. Using red light has been shown to allow people to be awake enough that and obviously see what they need to see in order to perform their activities safely but it does not seem to disrupt the cortisol rhythm that is the healthy normal cortisol rhythm. Okay. So, that's a lot of information and a lot of tools, and I really want to encourage everybody to get your behaviors right, get your nutrition right for you. I promise that if you start to implement some or ideally all of these tools, the quality of your sleep will increase tremendously. And of course, in doing so, the quality of your daytime alertness and your ability to focus will improve tremendously. Again, sleep is the absolute foundation of your mental health, your physical health, and your performance in all endeavors. And last, but certainly not least, thank you for your interest in science.

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