

Huberman Lab #8 - Optimize Your Learning & Creativity with Science-based Tools

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Introduction

Welcome to the Huberman Lab Podcast where we discuss science and science-based tools for everyday life. My name is 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 and effort to bring you zero cost to consumer information about science and science-related tools. In keeping with that theme, I'd like to thank the sponsors of today's podcast.

Our first sponsor is InsideTracker. InsideTracker analyzes data from your blood and DNA to help you better understand your body and health and health needs. I've been getting my blood tested for many years now because it just turns out that many of the things that are important to our health and well-being can only be detected in a blood test or a DNA test. InsideTracker makes that really easy. They can come to your house to take those samples if you like or you can go to a nearby clinic as well. The major problem with most blood tests and DNA tests is that it's very hard to make sense of the information you get. You get a lot of numbers related to metabolic factors, endocrine factors, etc. InsideTracker makes it very easy to decipher what those levels in your blood and DNA mean and what to do about them. They have a very easy to use dashboard that if you go to it, it can inform about lifestyle choices such as adding or subtracting certain forms of exercise or nutrition - other things related to supplementation. It's a really powerful and easy to use program. If you want to try InsideTracker, you can go to insidetracker.com/huberman and put Huberman at checkout to get 25% off any of their programs. That's insidetracker.com/huberman and put 'Huberman' at checkout.

The second sponsor of today's podcast is Athletic Greens. Athletic Greens is an all-in-one vitamin mineral probiotic drink. I've been using Athletic Greens since 2012, so I'm delighted that they're sponsoring the podcast. I started using Athletic Greens and I still use Athletic Greens because I find it very complicated and almost dizzying to figure out which vitamins and minerals I need to take in order to just cover my nutritional basis. Taking Athletic Greens makes that very easy. It also tastes very good. I mix mine with water, a little bit of lemon juice, and I really like it, so I drink it once or twice a day. The probiotics that are in Athletic Greens are also important to me because there are a lot of data now showing that the gut microbiome - which is supported by probiotics - is important for things like the gut-brain axis, mood, endocrine factors, metabolism - many, many biological functions. So, by taking Athletic Greens, I get the vitamins, the minerals, and the probiotics all in one easy-to-consume, great-tasting drink. If you want to try Athletic Greens, you can go to athleticgreens.com/huberman, and if you do that, you'll also get a one-year supply of liquid vitamin D3K2. There are a lot of data now as well showing that vitamin D3 is important for immune function, for mood, endocrine factors, as well as other systems in the brain and body. That's athleticgreens.com/huberman - and I should also mention, if you do that, you won't just get the vitamin D3K2 year supply, you'll also get five free travel packs of athletic greens. Mixing up powders when one is on the road - either in the car or in a hotel or on the plane, etc. - can be kind of messy. These little travel packs make it really clean and easy. So, once again, if you go to

athleticgreens.com/huberman, you'll get a special offer of your Athletic Greens, but you'll also get the year supply of vitamin D3K2 and the five free travel packs.

The third sponsor of today's podcast is Madefor. Madefor is a behavioral science company that makes attaining positive changes and growth mindset easy through a simple set of steps and a monthly program. The company was founded by former Navy SEAL Patrick Dossett and Tom's founder Blake Mycoskie. I'm the head of their scientific advisory board and the other members of the advisory board include people like the director of the Chronobiology Unit at the National Institutes of Mental Health, members of Harvard Medical School, and many other people who are serious about taking science and developing protocols that can be applied towards positive habits and growth mindset. If you want to check out Madefor, you can go to getmadefor.com. And if you purchase any of their products and put 'Huberman' at checkout, you'll get 20% off their program. In addition to that, we do a monthly Zoom call where the members of Madefor get on and Patrick and myself - sometimes Blake as well - discuss the Madefor program and the personal goals and things that people are trying to achieve with the program - so it's a dialogue back-and-forth on Zoom call once a month. Once again, that's getmadefor.com, put in 'Huberman' at checkout, and you'll be able to get the 20% off as well as access the monthly Zoom calls with us.

Let's talk about neuroplasticity. More specifically, let's talk about how we can optimize our brains. Neuroplasticity is this incredible feature of our nervous system that allows it to change itself, even in ways that we consciously decide. That's an incredible property. Our liver can't decide to just change itself. Our spleen can't decide to just change itself through conscious thought or through feedback from another person. The cells in those tissues can make changes, sure, but it's our nervous system that harbors this incredible ability to direct its own changes in ways that we believe - or we're told - will serve us better. Today's a really special episode because while we are going to talk about science, and as always, we will delve into mechanism, today's episode is really geared toward answering your most common questions about how to leverage neuroplasticity. The previous episodes were about focus and how to achieve focus for sake of plasticity, as well as the last episode, which is what are some of the hurdles into plasticity that relate to movement - how behavior can activate plasticity - as well as how to activate plasticity for behavior itself - how to get better at learning certain movements. Today's podcast is really directed toward answering your most common questions and the bigger theme of how does one go about optimizing their brain - or even think about optimizing the brain. What is this thing that we're calling optimizing the brain? In doing so, I'm also going to share some of my typical routines and tools. I don't share these because I think that they are the only ones that are available out there - certainly they're not. Nor do I share them because I think that everyone should do them just because I do them - certainly not. I share them because many of you have asked for very concrete examples of what I do and when. And so I'll share those with you and you can decide whether or not those protocols are for you or not. Everybody's different, but there are some common features of how we are all put together at the level of the nervous system and body that direct us toward particular practices - particular routines - that can be especially powerful for neuroplasticity. So I want to open up the discussion today by emphasizing something that's fundamentally important, which is that plasticity is not the goal.

Plasticity is Not the Goal

Plasticity is never the goal. Plasticity is simply a state or a capacity for our nervous system to change. And so nothing makes me more frustrated, perhaps, than when I hear, "Oh, you know, this pill, this potion, this practice - it gives you plasticity." Plasticity is just change. The real question is: What are you trying to change? And specifically, what end goal are you trying to achieve? Specific end goals might be extremely specific, like you want to learn how to speak a particular language, or you want to learn a new motor skill, or you want to get very good at calculus, or you'd like to forget the bad emotions related to a particular human being or experience. Or it can be more general, like you'd like to be more creative. We'll actually talk about creativity today. Or you would like to achieve more focus or you'd like to be less stressed. So, it's very important that you understand that plasticity and achieving plasticity is the first step in what we call optimizing your brain. You don't want your brain to be plastic all the time. In fact, one of the major questions - one of the major unsolved mysteries of neuroscience - is how each and every one of us wakes up every day and knows who we are. Why should that be? Well, the brain is plastic. It has a capacity to change throughout the lifespan, but it's not so plastic that every night when we go to sleep or in our waking that the connections get reconfigured so much so that we forget who we are, or how to walk, or how to eat. It's a good thing that we don't have such robust plasticity or ongoing plasticity that we have to restructure ourselves each day. It's part of what gives our life continuity. So remember, plasticity is not and is never the goal. The goal is to figure out how to access plasticity and then to direct that plasticity toward particular goals or changes that you would like to achieve. And I should just mention, there's no rule that in life you have to leverage this incredible thing called neuroplasticity. No one said you had to do that. This podcast and this episode is particularly for people who are either happy or unhappy with where they're at with a particular aspect of their life and they want to shift it in some positive way. And many of you listening might say, "Wouldn't everyone want to do that?" Well, actually, there are a certain number of people that are pretty good where they're at and they don't want to change and that's terrific. And I tip my hat to them and I think that's wonderful. If ever they decide that they want to leverage these plasticity mechanisms, they can at any stage throughout the lifespan. Let's start by talking about the different systems within the nervous system that are available for plasticity. And in doing so, I'll frame them in the context of what I do on a daily basis, on a weekly basis, and on a yearly basis.

Types of Plasticity

First of all, there are several forms of plasticity. They have names like long-term potentiation, long-term depression - which has nothing to do with emotional depression, by the way - and things like spike-timing-dependent plasticity. Those names are used to describe cellular phenomenon. The actual ways that the synapses - the connections between neurons - change. I'll mention those things and I'll give a little more meat as to what they are, as I mention them. But that's probably not the best way to think about plasticity in terms of optimizing your brain. The best way to think about it is in terms of short-term, medium-term, and long-term plasticity. Short-term plasticity is any kind of shift that you want to achieve in the moment or in the day, but that you don't necessarily want to hold on to forever. You might say, "What kinds of things are those?" Well, for instance, short-term plasticity might be, you wake up earlier than you would like to catch a flight. You're not

feeling particularly alert and you want to use a protocol or you decide to use a protocol - which could be coffee, or it could be a certain form of breathing, or it could be some other tool - to become more alert at a time of day when normally you aren't that alert. But your expectation is that when you return home, you will discard with that - the need to do that at 5:30am because you'll be asleep at 5:30am. So, there's short-term plasticity - behavioral plasticity. Then there's medium-term plasticity, which are changes that you might want to make. I call this - with respect and a little bit of humor - or at least, my kind of humor - I call this the - the undergraduate pre-med phenomenon. For those of you that have worked with pre-meds - and I have tremendous respect for medical students and pre-meds - there is a - a kind of a stereotype, which I don't necessarily agree with, but the stereotype is that they want to know what they need to know for sake of the exam, but they don't really want to know. They just want the A. And I don't think that's always true. I've worked with a number of different pre-meds over the years and there are many of them that are absolutely passionate about the knowledge itself and they also wanted the A. But the pre-med phenomenon, as it's discussed among professors and TAs, is that - that - you know - you've got these students - they just want to know what they need to know so they can get the A, right? It's medium-term plasticity. They don't actually want it to be embedded in their memory too long or else they would actually care about the information. So, that's medium-term information and sometimes that's useful. For instance, if you go on vacation to Costa Rica, and you don't know your way around Costa Rica, and you want to learn the different town and the routes there, but you don't have any intention of going back. It's just medium-term. You want to just program it in for sake of your time there and then you want to discard it. Most of the time when we think about or talk about optimizing the brain, we're talking about long-term plasticity. We're talking about the kinds of changes that people want to make so that their brain reflexively works differently. This is what a child does when it goes from not knowing how to walk to knowing how to walk. It doesn't have to think about it after it learns how to walk. It becomes reflexive. Long-term plasticity is almost always the big goal. It's: "I want to know how to speak that language. I want to be able to do that skill. I want to be able to feel this way without having to put much work into it." And there are tools and protocols that one can do to achieve that and we are going to talk about those. We've talked about a few of them in previous episodes, but I will revisit those protocols today.

I'm going to frame all this in the context of the daily life, the weekly life, and the yearly life. And that's because neuroplasticity and optimizing your brain rides on a deeper foundation of this thing that governs plasticity and - in fact - in fact governs all our life called autonomic arousal - which is that we're asleep for part of the 24-hour cycle and we are awake almost always. If we push ourselves and stay awake, we're okay. We can do that for a night or two, but almost always we are asleep for a portion of it and we are awake for a portion of it. I've said it before, but I'll say it again. The trigger for plasticity and learning occurs during high focus, high alertness states, not while you're asleep. And the focus and alertness are both key because of the neurochemicals associated with those states. But the actual rewiring and the reconfiguration of the brain connections happens during non-sleep, deep rest - which we'll talk more about as always - and deep sleep. So, you trigger the change and in sleep, you get the change. So, some of the things that we'll talk about today about optimizing the brain are centered around not sleep, but around the autonomic arousal system. We have this system of neurons in our brain and body that's just incredible that wake us up and make us alert.

And when we're not accessing that system - well, we cannot access plasticity. We cannot optimize our brain. Likewise, if we cannot sleep well and we can't rest well, we will not access plasticity and rewire our brain because that's when the actual configuration between the connections occurs. So to set this in context, I wake up each day and I'll be totally honest, I usually don't feel like bouncing right out of bed. I usually don't feel completely rested. And that's not because I don't get enough sleep. It's probably because I'm not terrific about timing my sleep so well. Now, this month isn't about sleep. That was the previous month, but I really want to emphasize a few points. I wake up generally more tired and groggy than I would like because I tend to go to sleep too late. It's just something that I do. I now tend to get up early either because I set an alarm, because I have things to do, or because I naturally wake up early because of the light coming in and so forth. Well, what that tells me is that I'm probably somebody who's natural circadian rhythm - you may have heard of chronotypes - these are genetically programmed things - but chronotype is shorter than 24 hours. It means that the cycle of waking and alertness for me is probably shorter than 24 hours which means that getting some light in the late afternoon will help me shift and make my cycle a little bit longer. It will phase delay me. If that doesn't make any sense, see a previous episode. But what it really means is getting some light in the afternoon will allow me to stay up a little bit later. But what it means is that I'm not really matching my hardwired needs of going to bed probably at 8:30 or 9 and waking up at 4am. I tend to go to sleep around 10:30 - 11 - lately around 11:30 or 12 - and then I wake up at 6. And so, of course, I'm going to feel groggy. So, neuroplasticity will allow me to optimize my wakefulness, but I have to do something in order to access it - that. And some of you may already be anticipating what I'm about to say, which is, "Oh, no. He's going to tell us to get sunlight in our eyes in the first 30 minutes of the day." I am going to tell you to do that, but I'm going to also tell you two things that I have not discussed before, which relate to the plasticity between the melanopsin cells - these sunlight detecting, bright light detecting cells in our eye - and the circadian clock.

Melanopsin Cell / Circadian Clock Connections are Plastic

I've never said this before in this podcast, but it turns out that the connections between these melanopsin cells and the circadian clock are plastic throughout the lifespan. There's a massive configuration of the connections there and a cell type called the astrocytes - which are a glial cell - are actively removing and reinforcing connections between the eye and that clock every day. Now, this is incredible because other aspects of your brain that, for instance, represent you knowing who you are when you wake up in the morning or what your name is - assuming that you're old enough that you've already learned your name - one of the first things kids learn - it's something we rarely ever forget - those connections are changing all the time every 24-hour cycle, so there's an opportunity for short-term plasticity. So, that's why I view sunlight first thing in the day. It helps me wake up.

Circuit Between Circadian Clock and Adrenals

The other thing that I do is that there's a circuit that exists between the circadian clock and our adrenals - that I've talked about before - that triggers the release of cortisol first thing in the morning that wakes us up - especially when we view light. So, if you're groggy in the morning, that's

why viewing light is helpful. But the interesting thing is if you start viewing light frequently in the morning, then those connections between the melanopsin cells and the circadian clock become primed - or potentiated, we would say. They become stronger for the anticipation of light and you naturally start waking up earlier feeling more alert. So, what this says is - and what I do is - I get that regular light because I know that some mornings I'm just not going to feel very alert. I'll feel especially tired and I might not be able to access sunlight - because it's really overcast, or I'm traveling, or some other feature - but the system is plastic so it's shifted in the right direction. Now it will shift back because it's short-term plasticity after about 2-3 days. So, you want to try and get the sunlight exposure on a regular basis.

Delaying Caffeine for First Two Hours

The other thing that I do is I delay my intake of caffeine for the first 2 hours that I'm awake. Now, this can be very painful for people, but earlier we talked about the adenosine system and how the accumulation of adenosine makes us sleepy and caffeine suppresses adenosine. It makes us feel alert. But we know that if you ingest caffeine immediately on waking, the signal to the adrenals to release cortisol - which is a healthy release of cortisol - and the suppression of adenosine that - that - that happens as we come out of sleep - and in deep sleep - the suppression of adenosine - if you ingest caffeine too early, there's a mechanism by which the adenosine competes for the receptors, etc. so that you have a mid-morning crash. Because if the - if caffeine - the way it works is if caffeine is occupying the adenosine receptor, then the natural endogenous mechanisms for suppressing adenosine are not actually going to have their action. So, the brain to adrenal axis is subject to plasticity also. And so by delaying caffeine until about 2 hours after waking, I'm able to capture and reinforce - to potentiate - the neural circuit that exists between the circadian clock and the cortisol release in the adrenals - as well as leave those adenosine receptors unoccupied so that I can then use the caffeine to get a natural lift in alertness and focus 2 hours later, as opposed to using it just to wake myself up out of sleepiness. So, while I'm sure there are some eye rolls out there and some yawns about: "Oh, no. It's the sunlight in the morning thing again." It's a powerful tool for readjusting these circuits - so the short-term plasticity. And the reason for delaying caffeine for the first 2 hours of the day - even if it's painful to do for the first couple days - is that then you naturally start to wake up more readily in the morning without caffeine because the adenosine is suppressed and you don't have these competing - it's an - it's called a competing antagonist for the adenosine receptor. So, I wake up - I get sunlight in my eyes. Lately - because I wake up very early - I do use a bright light to stimulate alertness. It's not actually designed for that purpose. It's just a light board that has about 900 lux. And then, I delay caffeine. Some of you have asked, and again, I'm not saying that anyone has to do this, you know, what exactly do you drink? I'm a big believer in black coffee, I just happen to like black coffee. People have asked me about, and I don't want to name brand names here about this type of coffee or that type of coffee mixed with these other kinds of things. Will that increase focus? You know, I'm going to talk today a lot about the use of diet and fasting and timing of foods and certain kinds of foods. But to be honest, black coffee is just a simple choice that's always worked for me.

Dehydration

I also make sure I hydrate first thing in the morning. There is plenty of data now showing that even a slight increase in dehydration - meaning just when you're lacking water - can make people have headaches. It can provide an - some additional photophobia. For those of you that are migraine-prone, bright light can trigger migraines. That's no surprise to those of you that get headaches and migraines. But dehydration can - can compound the vulnerability to migraine and headaches. So, I drink water - I drink black coffee or I drink maté - which is just a - because I have Argentine lineage - which is just a high-caffeine drink first thing in the morning. But I delay it until 2 hours after I wake up. And that's because I want the circuits between my eye and my - and my circadian clock and my adrenals to be functioning in a particular way so that then later, the caffeine is an addition. It adds more alertness.

Now, this is a discussion about how to optimize your brain. Many people who wake up quickly and just naturally feel like bouncing out of bed - I envy these people - they will do just fine by going into a learning bout or taking care of whatever it is that they need to take care of - sometimes that's kind of more mundane tasks like email or - and whatnot. Here's a - a - more or less - a rule about how the brain functions vis-a-vis focus, learning and creativity. And I'm going to discuss this much more in future episodes. Generally, states of high alertness - when we're very, very alert - are great for strategy implementation - when we already know how to do something and it's just a - simply a matter of plugging the correct element into the correct boxes. Things - I've talked before about duration, path and outcome as the three things that the deliberate conscious brain is trying to figure out in order to perform certain tasks - even cognitive tasks. This is the sort of thing that we are very good at when we're well rested, and we're focused, and our autonomic arousal - or our alertness rather - as it - is at a high level. If you are somebody who is hitting that alertness phase of your day very early - right after you wake up - that's a great time to move right into things that - at least the research says - you already know, have the strategy, and you just want to implement the strategy. This is where I fundamentally depart from the idea that, "Oh, you know, you have to do the hardest or most critical tasks throughout the day." Sometimes the hardest and most critical tasks are tasks that require creativity. And as we'll soon talk about, creativity and tasks related to it oftentimes come - come to us best - or the brain is best at achieving those - when we're in states of calm or even slightly drowsy - which is something that's interesting and what we'll get into. But for me, for instance, I get up - I'm not terribly alert first thing. And so, I try and just get my brain and my thoughts organized. It's not a time for me to be responding in a very linear fashion to emails or carrying out calculations. That comes about 2 hours later. And I think I'm - many people out there will relate - mid-morning is when we tend to - when many people tend to achieve their peak in alertness and focus.

Now, many times I get the question - and this is - what I'm about to say is directly related to the hundreds of questions I got about this: Should I use background music in order to learn? Should I have - you know - construction next door? Is that a good thing or a bad thing? Is it better to be in complete silence? Etc. Now, this will vary. Some people can tolerate their own noise within their head much better than others. Other people find that having some background noise helps cancel

that out. But there's a simple rule of thumb that one can use because at least my experience is that sometimes background music - background noise - is very helpful for allowing me to focus. And other times, it's very distracting. So, what actually governs that? Well, we have to ask ourselves: What is at the source of the lack of focus? If our lack of focus is because our autonomic arousal - our alertness - is very, very high. We had a little too much coffee or - if there is such a thing - slept a little too long, or were really stressed, or really activated - and we can't seem to focus. In that case, eliminating background noise and really just trying to get silence so that we can quiet some of that autonomic arousal is going to be best for learning and for implementation of things we already know how to do - for any kind of focused linear task - which basically learning is a focused linear task. It's that you're just not necessarily performing it well all the time - last time we talked about making errors. So, as a rule of thumb, if you're feeling too keyed up, then silence and quiet is going to be helpful.

In fact, if you're very keyed up, a particular circuit related to the basal ganglia starts getting triggered more easily. And this circuit I'm going to talk about in depth, but it's called the "go"/"no-go" circuit. We have circuits that connect our forebrain to a structure in our brain called the basal ganglia - which is actually a collection of structures. And the forebrain - which is involved in rational thought, and thinking, and planning, and action - is always trying to plan: What should I do? And then, implement that action. And the basal ganglia are intimately involved in that discussion. There's a reciprocal loop of communication between basal ganglia and cortex. The basal ganglia has one set of connections to the cortex - and the cortex back to the basal ganglia - that facilitates "go". It facilitates action. And the molecule - the neuromodulator dopamine - triggers the activation of "go". It tends to make us want to do more things. It tends to make us biased toward action by the way that dopamine binds to something called the D1 receptors - just a particular type of dopamine receptor for those of you that want to know. The "no-go" pathway - the pathway in the basal ganglia and cortex that suppresses action - involves dopamine binding to this other receptor called the D2 receptor. Now D1/D2 receptors - you can't just consciously decide, "Oh, I only want my D1 receptors and my D2 receptors to be active." You have to think about which sorts of states of mind and body facilitate "go" and which ones facilitate "no-go". Now this is critically important because doing focused work, accessing plasticity, and learning involve doing certain things and not doing others. So, here's how it works and here's how I apply it on a daily basis. Because I tend to be most alert first thing mid-morning or so - and then, I generally will have my caffeine mid-morning - my peak of alertness in the early part of the day is occurring for me sometime between 9:30 and 11am. That's just me. Other people might experience that immediately after rolling out of bed. They might be wide awake and ready to go - in which case they should be cautious about throwing caffeine into the mix because of the - and it's going to make them very, very alert. There are three sort of levels of autonomic arousal - of alertness - that bias us more toward "go", "no-go", or both. And this relates to a question that I've gotten now hundreds of times from you in the comment section for this podcast, which is: Is it better for me to listen to music in the background while I work and learn or should I have complete silence? And the answer is: It depends. But it doesn't depend randomly on who you are or even necessarily time of day. It depends on your overall level of autonomic arousal. And it depends because autonomic arousal - level of alertness - biases the extent to which we are

more prone to "go"s - to action - or to "no-go"s - to suppress action. And dopamine is this molecule that's swimming around and is going to bias one or the other responses. So, here's how it works. Let's say I'm very alert. Maybe I got a particularly good night sleep the night before. I had a little too much coffee and I'm going to sit down to some work. The thing to know - and what I always tell myself - is when I'm very alert, I am very prone to "go" - to action. But I'm also prone to not "no-go", right? I'm not going to be very good at suppressing action. So, those are two different things. Being biased toward action and being biased toward suppressing action are two different things, okay? So, those are push/pull - toward action - suppress action. So, when you're very alert, the tendency is for everything to be a stimulus. This is why when people say, "Well, should I just take a drug like that will increase my level of epinephrine and alertness? Will that help me learn better?" No, because it will make you do things, but it will also make you less good at suppressing actions that you need to suppress. So, if I'm very alert - particularly alert for me - and I recognize what that state is, of course, because everyone will be different - I know what it is for me - then, I want silence for learning. I want to shut down my internet - which I do. I sometimes use a program that I - I believe is a free program called Freedom where it actually locks you out of the Internet for a particular time. They're not a sponsor of the podcast. I just happen to use it. There's another version of Freedom where you go to the wireless thing and you turn it off. You disconnect from the wireless. That's the other one. Although, many people have a hard time not reactivating it. So, I'm trying to shut down the "go" pathway towards distraction. And the other thing that I'll do is I'll generally turn off my phone, put the phone outside in the car, or in really extreme cases, I'll throw it up on the roof - which is hard for me to retrieve now - so that I can't get to it. So, if I'm very alert, I'm aware that I will have a bias toward action. It will be hard for me to suppress non-action, but that it's very non-specific - because the next kind of level down of alertness - or autonomic arousal - is clear, calm, and focused where we have that kind of sweet spot between our willingness to pursue action - we're in a mode of "go" - and it's not always physical action, but it can be pursuing hard bouts of learning - but that our ability to suppress is also very good. And this is because - and I don't want to get into too many details - because of the way that dopamine competes for these dopamine-1 receptors in the "go" pathway and dopamine-2 receptors in the "no-go" pathway. They're always in this kind of push/pull. And so there is a sweet spot. And that sweet spot isn't "flow" where - it isn't some sort of state where all of a sudden things come naturally to us. The state that we're trying to achieve that's optimal for learning is one in which we have the energy and focus to pursue, but we also have the energy and focus to suppress action. So, the basal ganglia are kind of working in a perfect kind of singsong-y manner through this parallel pathway. Now as we get tired or as we round out an ultradian cycle of about 90-minutes, what happens is our fatigue - even if it's not a physical fatigue that makes us want to go to sleep - but our mental fatigue starts to accumulate because these pathways of "go"/"no-go" are actually very metabolically consuming. So, what I recognize is that as I start to falter - I have a harder time engaging and going - I also know - or going toward the goal rather - I also know that my reflex toward actions that are unrelated to the learning are also going to start increasing because I'm not going to be able to suppress action and activate the "no-go" pathway. So, if this all sounds like a mouthful, let's make it very simple for you. When you are very alert, the best situation for learning is going to be silence. It's going to be complete quiet. If you are low arousal and you're tired and you're kind of sleepy, a lot of people find that having some

background chatter and some background noise can help elevate their level of autonomic arousal. And that's because our auditory system and our visual system are linked and are part of really what's called the salience network - which is that we're always scanning our environment for things. And when we have a lot of things in our environment to scan, generally our level of alertness goes up. This is why environments that are very stark or have very little or very few objects in them tend to make us feel kind of calm because our salience network kind of shuts off. A lot of people don't like that. They'll go to a meditation retreat or they'll go into an environment where there's very little clutter - especially city people - and all of a sudden, they start feeling really, really anxious. And that's because their internal level of autonomic arousal is really high and it's not being occupied by all this stuff to pay attention to. And so their salience network starts to turn inward. They move from exteroception to interoception. They're not looking outside themselves. They're looking inside themselves and there's a lot of noise in there. So, as a rule of thumb, if you tend to be kind of on the high level of alertness, and kind of anxiety, and - I'm not talking about clinical levels of anxiety - but you tend to be pretty high-energy - well then, you are definitely going to benefit more in a learning bout from learning to "go" as well as activate the "no-go" pathway. And that requires a lot of energy. And when you have a lot of distractions in your environment, there's a high probability that you're going to be distracted from the learning.

Now, some people are just naturally more calm. They're like my bulldog, Costello - who is exceedingly calm. They're pretty mellow. They're kind of clear, calm, and focused all of the time. And those people actually are going to be less flappable. They're not going to be yanked around by background noise or they're not going aroused - you know - bothered from their learning or from their studying by a clanging of a pot from somebody in the kitchen. So, each one of us generally tends to ride up and down this autonomic ladder - so to speak - at different times of day. For most people, 3 hours after waking - those 3 hours - not 3 hours on the mark - but that 3-hour bin, tends to be the period in which they're most alert throughout the day - except I'll tell you later about a unique time right before sleep in which you're also very, very alert - naturally. So, that morning 3 hours is quite vital.

Now, many of you might ask about exercise and when to exercise. I think I may have mentioned this on a previous podcast episode, but the research shows that at least for performance, afternoon exercise might be better in terms of avoiding injury, etc. But in terms of rising body temperatures, they - it - and matching body temperature to a mental alertness, etc. - it's pretty clear that exercising early in the day, not only biases us towards waking up earlier, but that it also triggers the release of things like epinephrine and other neuromodulators that lend itself to a situation where we have heightened levels of arousal and mental acuity in the late morning and even into the afternoon. Now, this can be very good because if you want to restrict most of your focused learning to the early part of the day, exercising early in the day does set a neurochemical context - or milieu - for "go". It tends to trigger activation of the "go" pathway. And so for those of you - like myself - who have a hard time kind of engaging and getting into action early in the day, early morning exercise within an hour of waking - and certainly no later than 3 hours after waking - will give you quote-unquote "more energy" throughout the day. It will make you feel more biased for action. You

won't feel as lethargic. So, in kind of reviewing what I've set up until now - I do the morning light thing, I delay my caffeine 2 hours after waking, and then I generally try and get exercise in - in the first hour or ideally within the first 3 hours of waking up, and then I'll move into a focused learning bout.

Now, some of you wrote to me and said, "If I exercise early in the day, then I feel a crash afterwards." If that exercise is very, very intense - so you're depleting all your glycogen - so you're doing heavy deadlifts, etc. - chances are after you eat, you will start to feel a crash. So this relates to timing of nutrition. And just as a general rule of thumb, fasted states and low-carbohydrate states - I'm not talking about a keto diet around the clock or all week - but fasted states and low-carbohydrate states lend themselves to alertness. And that's because carbohydrates are rich in tryptophan and they tend to lend themselves to sleepiness. Of course, ingesting large amounts of any kind of food - any substance that fills your gut - will divert blood to your gut. So, if you eat a lot of food - regardless of whether or not it's a lot of carbohydrate or not - you're going to generally feel more sleepy. Now, many people - including everyone - use food to modulate their levels of autonomic arousal. And typically, eating shifts us more towards a state of calm and fasting shifts us more towards a state of alertness. And these are hardwired circuits that relate to the need and desire to find food - which requires action - or the so-called "rest-and-digest" system which it - diverts our resources and our energy towards digestion and makes us feel calm. So, I personally rely on water, maté, and black coffee first thing in the day in order to exercise and get into the first round of work. If I find that I'm too alert and then I generally will tend to eat and kind of bring down my level of alertness and will continue working. Now, this isn't a strict thing. And since people ask me what I do - and I'm not dictating that people follow it exactly, of course - or even generally - but I'll just tell you what I do. It - it is possible if you're drinking black coffee, and you're - or maté - and you're ingesting a lot of water that you're going to dehydrate yourself somewhat because of excretion of sodium. Provided you don't have hypertension, salt is a really good thing. A lot of people think that they're low on blood sugar because they're shaky and they can't think or they have a headache when actually they're low on sodium - especially if you're drinking a lot of caffeine. So, I'm a big believer in salt. I drink salt water first thing in the morning because I drink black coffee and that keeps my levels of alertness really good. I always thought that I had messed up blood sugar. I had - you know - shaky hands and I didn't know what was going on. I'd drink a little bit of coffee and feel too amped up. And it turns out that it was a sodium issue. And if I just drank water with a little bit of sea salt in it - or even just general table - typical table salt - then I felt rock solid in terms of my blood sugar. Now, again, I'm not a physician. I'm a professor, so I don't prescribe anything but I profess lots of things. So I don't want people who have diabetes or blood sugar issues to - you know - go off the rails. You're responsible for your health, not me. But it's an interesting parameter to think about and experiment with - you know - provided that your doctor says it's okay because I think a lot of people probably just too much sodium, but a lot of people might be sodium-deficient - in particular the people that are fasting. I typically eat my first meal right around mid-day - whether or not I've exercised or not. And the food content there is actually quite important to me. I don't know why this is. I don't have a scientific mechanism for this. But if I eat hot food for lunch, I get sleepy after lunch. So, I generally don't eat hot food for lunch. I might have a little bit of soup or something like that. But

in general, I rely on a low-carbohydrate meal. I'll eat meat, or salad, or some variation that - and nuts, and fats, and things like that - because of the choline content for focus - because the protein is good, in my belief - and because I believe in eating fruits and vegetables. I do that too. If I've exercised very hard early in the day, I do ingest starches like oatmeal, or rice, and fruit and things like that. Now, why am I telling you all this? Because hundreds - if not a thousand people - asked me: Is fasting good for focus? And indeed, fasting will increase alertness. But if you're so hungry or preoccupied with food that you can't focus - well then, it's not going to be good for learning. It's only going to be good for agitation. Now, I'll - I'm just going march - to continue to march through my day. And this is, of course, what I experience. Some people are quite different. But what I find is around 2 or 3pm I start getting a little groggy - a little bit sleepy. I will tend to shift my work from work that requires a lot of duration, path, outcome - really careful analysis and activation of the "no-go" pathway - meaning I'm trying to suppress the impulse to look at my phone, or answer email, or do other things. This is why I haven't emailed you back until 3 in the afternoon, by the way. Or responded to your text messages - whoever you are out there. Around early afternoon, I find I can do kind of typical more mundane tasks because those tasks are - require less - they have - require less cognitive load and they can be done - more or less - in and out of sequence. I can answer a couple of emails here, maybe answer that, email there. I don't have to do it in pure linear fashion. Any kind of linear work or learning work is going to take a lot of focus.

And then typically around 4pm or so, I do two things. Sometimes a little earlier - sometimes a little later - but I do two things. One is I make sure I hydrate - because if you're exercising and you're eating, you need to digest that food, etc. I make sure I hydrate, so I drink water. I try and refrain from drinking coffee in the afternoon. This is a new thing for me. I sometimes do it, but I try and refrain from that. And then I always do a non-sleep, deep rest protocol sometime in the afternoon. This is sometimes a 10-minute yoga nidra type protocol or a 30-minute yoga nidra type protocol. These are protocols that I have no relationship to - no business relationship to whatsoever. I've been doing them for years now. They involve listening to a script. We'll provide the links again 0 although we've provided them before. Or I'll do a hypnosis protocol from Reveri Health - which is my colleague David Spiegel's website - that has these free hypnosis apps or scripts that you can listen to. And those take me into a state of really deep rest - sometimes so much so that I fall asleep. And I always set an alarm so that I don't sleep for longer than 90 minutes. But typically this goes for about 30 minutes. And I do that because for me, by about 4:30 in the afternoon, I'm capable of doing basically nothing. I am just a complete Costello. I can't think. I can't do, I can't respond to email. I've just completely troughed my ability to function. I personally find it a mistake to at that point down a double espresso and charge really hard. It just doesn't work for me. I end up really disrupting my sleep schedule. I end up disrupting a lot of different things. So for me, I do the non-sleep, deep rest protocol. It really helps me later when I need to fall asleep. It helps with all sorts of things, as I mentioned before. But I usually emerge from that a little groggy or feeling like I have another whole day - a second wind - like I could just work, work, work, work, work - and then I'll do a second bout of learning. I'll do some sort of work that either involves linear analysis of something - so maybe numerical work or I'm trying to learn something. I generally try and really use those bouts of 90-minute focused energy after the non-sleep, deep rest. And as I mentioned in previous episodes,

there's a lot of evidence that these non-sleep, deep rest protocols can enhance and accelerate plasticity. The most recent and striking one is the study that we referenced last time in the caption notes. It was the Cell Press article - Cell Reports - great Journal. It was showing that these 20-minute kind of shallow naps and non-sleep, deep rest can facilitate sensorimotor learning. So, then I'll go into another learning bout that's caffeine-free. This learning bout is very different than the morning one. This is a work bout or learning bout that's more in the clear, calm, and focused regime because I've come out of this non-sleep, deep rest. I'm not ingesting caffeine because I want to make sure that I can sleep later that night really well.

Creativity

And this tends to be more when I do creative type work. Now creativity is a topic that we're going to spend the entire month on coming up soon. But creativity is a very interesting state of mind in which we're taking existing elements - things that we already know - and rearranging them in ways that are novel. You'd say, "Well, duh. That's what creativity is." But creativity has two parts. It has a creative discovery mode where you're kind of shuffling things around in a very relaxed way and kind of being playful or exploring different configurations. And then creativity also has an absolutely linear implementation mode in which you take the idea or the design you come up with and you create something very robust and concrete. And so creativity is really a two-part thing. And the first part of actively exploring different configurations - sometimes in a playful way - sometimes in a way that's almost random and just kind of exploring - that state is definitely facilitated by being relaxed and almost sleepy. That is not a state that I personally can access very well early in the day. I've tried to access it coming out of sleep because you - one would say, "Well, you're still sleepier early in the day." And it just doesn't work. Most of what I write down - most of what I do - is complete garbage. And so, what I found is there's this block in the afternoon of about 90 minutes where I can do creative type writing, or creative type imagination of scientific ideas, or experiments we might want to do. Science might not seem like a creative endeavor to many of you, but it is. It has a lot of imagining: "What if this? Or we could combine that?". And thinking of novel concepts or ways of arranging things. So, when you find yourself in that - kind of - kind of clear, common focused mode - creative works tend to come about very well in those regimes. I know that a lot of people out there rely on substances to access creative states. I'm not a marijuana user. It's just not the drug for me for a variety of reasons. I'm not a drinker. It's not the - not the substance for me for a variety of reasons. I'm not a cop. I'm not out here to tell people what they should do or shouldn't do. The problem with using substances to access creativity is that generally, the ones that - the substances that relax people will allow them to get into that creative brainstorming mode, but not so good at the linear implementation mode.

You know, the other day, I was remarking with a friend that there are some ads - some advertisements that I've seen over the years - that are just incredible. I'll just tell you what they are - so there's not - cryptic or anything. I'm revealing my taste here. There's a one - there's a particular perfume ad that Spike Jonze made that is just amazing. It's just - I'll put a link to it because it's just so cool. And it's just so - and it - and it has an a - I don't want to give away the end, but it has a feature of it that is particularly interesting to me as a neuroscientist. And it was just so cool. And I -

I grew up in the skateboarding thing. I knew a little bit about Spike's movies in skateboarding and he's, of course, made a lot of very impressive popular movies as well - full-length features. I don't know him personally, so this isn't a plug - not that he needs my endorsement for anything at all. But, the amazing thing about this advertisement is it's a kind of - it's a collection of things that you would never really think would be combined - and it involves different speeds of motion and - and all sorts of effects. I mean - it's like a real classic - like Spike Jonze kind of delivery. But, what's incredible is when you think about - not just the fact that someone had to imagine that - but to actually implement the steps in order to create that - when you see this you'll realize that was a ton of work. You can't just put that together randomly. And so, a lot of people - not Spike, clearly - but a lot of people who can - who have an incredible mind for ideas and novel - novel arrangements of things - they are great at accessing that state, but not so good at accessing the implementation state. And then, it's also true that a lot of people - and some who tend to fall on what we would call the more asperger or autism end of the spectrum - are very good at linear implementation. Now, I'm not talking about all forms of autism, of course. I'm sensitive to the fact that there are many forms on the spectrum. But some people are very good at linear implementation and that's a separate state from a creative state. So, that afternoon block is when I try and access the freer, kind of looser mindset that's associated with the fatigue that comes later in the afternoon. And for some of you, that state that favors creativity and creative learning might be better in the morning. I don't know. You're going to have to decide. For some of you, you're going to be late shifted - some of you are going to be morning shifted. But where we have alertness, generally, we are good at linear implementation. We're good at activating the "no-go" pathway - and suppressing action - and we are good at - at pursuing particular goals and strategy implementation. And where we tend to be more relaxed and we tend to be almost in a kind of sleepy mode - and so for me coming out of one of these non-sleep, deep rest modes or sleep - that's when we tend to be better at novel configurations of existing elements - which is creativity.

Psychedelics

And this brings about a question that I get all the time, which is: What about psychedelics? So, I am going to talk to some experts on psychedelics. I hope to bring some of them in. Actually, speaking of people coming in - or creatures coming in - a creature that's definitely not on psychedelics - who doesn't need any - is Costello - and he just arrived. He seems to be in a sleepy state most all the time. Hey, buddy. How you doing? Can you come in? Yeah. He's working on his 15th non-sleep, deep rest - episode of the day - which is generally followed by a 10-12-hour deep rest episodes - almost exclusively comprised of REM. And I know this because his eyes are open because they're so droopy, he can't close them all the way. And his eyes are going like this. And he's going down for the count. So - yeah, nice - big yawn.

Okay, so psychedelics. First of all, I want to be very clear. I am neither a proponent nor am I somebody who rejects the potential role of psychedelics. I do, however, think that psychedelics can be particularly hazardous for people who have preexisting psychological issues and are not working with a board-certified psychiatrist or physician - as well as for essentially all kids. I think that the young brain is basically in its own psychedelic state and just naturally. And all kidding aside, I think

that the young brain is so subject to neuroplasticity that drugs - which like psychedelics - which are very powerful - can be detrimental to the developing brain. That's just my stance. If anyone disagrees with me, I'd be happy to chat with you about it in a polite and - discourse. I'll be happy to listen as well as tell you more of why I believe that based on the data. I'm mentioning psychedelics because many of you asked. Here's the deal with psychedelics - at least here's how they work. In a nutshell, psychedelics were thought to unleash sensory processing and to make it less filtered. We have a lot of different inputs - from our eyes, from our ears, from our nose, from our taste, etc. - that are coming in all the time in parallel. And we have mechanisms that suppress some of those and allow us to only focus on things that are happening visually. Generally, we don't have synesthesias - unless some of us happen to have synesthesia. We don't blend what we see with what we hear in a way that is confusing to us. We know what's making sounds and we know what is a visual stimulus. On psychedelics, people report being able to smell colors or to - you know - hear - hear trees, etc. And that's because there's a lot of sensory blending. However, that's led to the misconception that sensory blending itself is a creative process. There's nothing creative about sensory blending. You know, there's - the essence of a creative process is that some novel configuration of elements - whether or not it's notes on a piano, or whether or not it's words on a page, or whether or not it's numbers, or whether or not it's movement - that some way in which those are configured in some new way - that the algorithm - the way in which they are configured - makes sense to the observer. And this is a key thing. It seems to me that when people report their psychedelic experiences, it makes a lot more sense to the person who experiences it than to the observer. And so, creative works, by definition, are new ways of configuring things that lend themselves to a bigger - bigger, or greater, or deeper, or novel understanding on the part of the observer. And just sensory blending is not going to accomplish that. Now it is true - and there's a great review in the journal Cell - excellent journal - about how psychedelics work and it turns out they don't just work by allowing for more sensory blending. They do - because of the way that they activate certain serotonin receptors, etc. - they do lend themselves to more lateral connectivity between different brain areas - more novel associations. So, in principle - in principle - I should say not necessarily in practice - but in principle, they do allow different areas of the brain - maybe even the two sides of the brain - to communicate more broadly than they would normally. So, that has certain elements that speak to creativity. But it can't simply be the case that psychedelics are the portal to creativity, because creativity - as I mentioned before - involves not just novel associations and a breaking of kind of space-time rules. It also involves reconfiguring things such that the new space-time rule that one comes up with is interesting, stimulating, and kind of in many cases delightful to the observer. And that's why many claims that - you know - psychedelics open plasticity or they increase creativity. That's not sufficient for me personally. I'm curious about - does it - not just open the creative thinking process - this novel configuration process - but: Does it also lend itself to the implementation of creative works? And the answer is: No. In most cases it has nothing to do with creative implementation. Now, I think that there may come a time - and certainly there are clinical trials that are happening now - where psychedelics are leveraged toward particular clinical goals. And I want to tip my hat to the work at Johns Hopkins that's happening now, which really lends itself to the idea that - early preliminary data and some of the papers are coming out - they are really fantastic - showing that there may be some excellent roles for certain

psychedelics in certain clinical contexts. These are clinical studies done with a psychiatrist present - that is authorized to do that - that can help people through depression, trauma, etc. And we're going to spend a lot of time talking about that - including with some of those folks running those studies. So, we can look forward to that. So, all of this is to say that: No, I don't take psychedelics to access creative states. That's not where I think the major role - the important role - of psychedelics might show up if it's going to be for humanity. I think that it may have these important roles in the clinical context - provided it's done legally and safely. I think that the creative process being a two-stage process means that I am personally best served by having this period of nonlinear exploration of concepts - whatever it is I happen to be working on in the afternoon. But then, I'll actually shelve that work. I'll just set it aside and then, I'll revisit it the next day - or even the next day - to see whether or not that the work itself is ready for deliberate linear implementation - which I would want to do during one of these high - highly focused states. So, the long and short way of saying this is that when we're very alert, do linear type of operations. When we tend to be more sleepy and more relaxed, that's when creative works can first be conceived, but their implementation requires high levels of alertness.

Now, that gets us more to the kind of late afternoon/evening. Now, I am - as I mentioned before - I'm a proponent of getting sunlight in the evening as well. This is a critical thing that I have not mentioned before. Here's how it works. Many people now have heard me say getting light early in the day is important, but that will advance one's clock. It'll make you want to get up earlier the next day. By getting light in the evening, it accomplishes two things for me. First of all, it makes sure that I don't get up too early - that I'm not waking up at 3 or 4 in the morning because it's going to shift my clock - it's going to delay it a little bit. And so, this is really important. If you want to keep your schedule on a normal routine - on a regular 24-hour cycle - and not have your circadian rhythms of sleep and wakefulness drifting all over the place - and you want some predictability to how your mind is going to work in order to optimize learning and performance - well then, you need to get morning light and evening light. The morning light is going to advance my clock - make my system want to get up earlier. And the evening light is going to delay my clock a little bit so that on average, it kind of bookends my circadian mechanisms. And I'll basically want to go to sleep at more or less the same time each night and wake up more or less at the same time each morning. That's how it works. And that's a hardwired mechanism. That's not some subjective thing that I tell myself. That's a hardwired mechanism. So, that gets us to the evening. And generally in the evening, I'll get that light by going outside or sometimes I'll do it by turning up artificial lights brightly. And then, I'll start to dim them for the evening because - as I've mentioned many times before and I'm not going to belabor the point - you want to minimize your light exposure - especially overhead bright light exposure - regardless of whether it's blue light or not - in the evening from about 10pm to 4am. Some of you asked, "Wait, I thought it was 11pm to 4am?" Well, it is. But 10pm to 4am is even better. It's just that when I originally said, "10pm to 4am". People were like, "That's impossible for most people to adhere to." So, for me, it screens off - it's dim lights - and that's what favors falling asleep and a good night's sleep for me. Since we were talking about food earlier, I'll just revisit a little bit of what I said before. My evening meal tends to be more carbohydrate-rich. More - if I have proteins, it'll be like eggs, fish, or chicken, or something of that sort - or no protein. And I eat high

carbohydrates. So, I'm not one of these people that's keto or high - high meat only - or anything like that. Remember, fasting and low-carbohydrate states facilitate alertness. Carbohydrate-rich foods facilitate calmness and sleepiness. They stimulate the release of tryptophan and the transition to sleep. So, that's why I do them late in the day. Also, if you've exercised early in the day - especially if it's weight-bearing exercise or - everything's weight-bearing exercise I suppose - unless you're an astronaut, but - and you're in space - but, if you're early in the day exercising with weights, or you're doing a long run, or something - sooner or later, you need to replenish glycogen. And I realize that the keto-nistas out there are going to say, "Well, gluconeogenesis will allow you to replenish glycogen" etc. I'm just going to call out the lie right now because I feel like doing it and because I think it just hasn't been stated, which is that not everybody - but a lot of the people that are proponents of high meat keto-diets - fine - that's fine if that's what they want to do - and as you recall, I do relatively ketogenic diet during the day to - for alertness or fasting - but a lot of those people can replenish glycogen really well without ingesting carbohydrate - so-called gluconeogenesis and enhanced protein synthesis - because they are hormone-enhanced. And it's just - I've been around a while - I know what this looks like. They're either thyroid-enhanced or hormone-enhanced - and I don't pass any judgment. But when you look at people who look amazing on keto and are able to have a lot of energy and replenish their glycogen on keto, they are - in many cases, not all - but in many cases they're hormone-enhanced. They're taking exogenous hormones that allow them to synthesize and repair muscle in ways that people who aren't taking those exogenous hormones can't. This is not just true of the men, by the way. This is also true of the women. And this is a whole discussion unto itself - probably not directly related to this month of the podcast. So, I don't mind that people do this. But one problem is when people are following ketogenic diets all the way through to sleep and they have trouble with sleep or they're doing long bouts of fasting and they're having trouble falling asleep. It makes sense. It's because their autonomic arousal is tilted towards epinephrine release, norepinephrine release, and dopamine release. So, they have a lot of energy, but they have a hard time calming down and getting into deep sleep. I tend to achieve that state using carbohydrates and it also replenishes glycogen. So, again - you know - I'm not trying to draw any fire. But if I do, I'd be happy to have a conversation about all that. Again, no judgment. But I think that most people out there are not aware of some of the other variables. Remember, good science is about isolating variables. And so, oftentimes what we're seeing in social media is we're getting presented single variables and we're not seeing the full context of the other variables that are being manipulated. So, I eat pasta, and rice, and vegetables, and things like that in the evening. Also, I just find - maybe I'm becoming one of the last people that does that - although, I hope not - I hope there are others out there like me - but, I just - from all the literature speaks to the fact that carbohydrates not only do that, but they also help maintain healthy thyroid function, etc. So, that's my bias. That's what I do. I do avoid caffeine and whatnot in the evening. I do take supplements and I'll be happy at some point to put out the complete list of supplements that I put out - that I take - out there. But in general, these are the core things that I do and they relate to a lot of the questions that - that you've been asking over time. The next piece of scientific data that I'm going to describe is a very important piece of scientific data for sake of understanding how to optimize your brain and access sleep. It also can help avoid a lot of anxiety issues. And these relate to data from Charles Czeisler - doctor - he's an MD - Chuck

Czeisler's lab at Harvard Medical School. He's run a sleep lab out of Harvard Medical School for a long time now. It does very impressive work. What he's shown is that the peak output of the circadian clock for wakefulness - in other words, the peak of our wakefulness and the suppression of the sleep signal - actually happens very late in the day. So, we have this trough of activity and body temperature is lowest right before waking. Then as we wake up, our body temperature goes up and into the afternoon, it continues to go up, up, up, up, up, up. And then, it tends to fall in the evening and towards bedtime. But there's a brief blip of release of peptides and other substances from the - from the sleep centers in the brain and the suprachiasmatic nucleus - the sleep centers - this pre-optic area that - if you want to look that up - this pre-optic area - not far from the circadian clock - that signals the peak of alertness and wakefulness about an hour before bedtime. He's like, "Woah, that's really weird." But a lot of people get into bed. They're ready to go to sleep and they're wide awake. And they think this is a natural thing or there's something wrong with them. And actually, it's not. This - it's believed - I don't know, - again, I wasn't consulted at the design phase - but, this is - it's believed is a signal that is helpful to human beings to start gathering up resources and securing themselves for a night's sleep - during which we - you know - historically, were very vulnerable to attack from other humans, and from animals, and so forth. And so, that desire to run around and clean the kitchen, or organize things, or just a general feeling of internal anxiety late in the evening - that's a natural blip that naturally passes after about 45 to 60 minutes. Now, that's often the time when people start stressing about the fact that they have something and do the next day and they worry about not being able to sleep and it can cascade into a whole set of things. So, another thing that I do throughout my day is - I know that early day, I'm going to be alert - afternoon, I'm going to be kind of sleepy - and then, as the evening comes around - in addition to doing all the other things I'm doing - I anticipate a peak in alertness and activity and I don't worry about it. I use that perhaps to get organized for the next day, but basically I just go through - if I'm going to do anything, it's going to be very mundane task like cleaning or things that require almost zero effort - and that probably speaks to my cleaning abilities too. But the fact of the matter is we don't just go drift off into sleep. There's this blip of alertness right before sleep that I hope just cognitively knowing about will be helpful to people.

And that raises yet another theme that I think is going to be very important, which is physiological mechanisms like these changes in alertness or using breathing tools - something we'll talk about in future episodes - to shift our levels of autonomic arousal. Those are concrete biological phenomena. So is fasting. Fasting will increase alertness that way. So is caffeine. Not everybody's susceptible to caffeine to the same degree of others, but it's a physiological mechanism. We know the receptors. We know the ligands as they're called - which bind to the receptors. We know the mechanisms. They involve cortisol and epinephrine. Those are the sorts of things that I personally try and leverage toward my learning and optimization of my brain and my activity. Doing physical activity early in the day, for instance, tends to give us a longer duration wake up signal and tends to accelerate waking up early in the day. That's why working out late in the day can sometimes cause people to have trouble falling asleep. It will also phase delay you - make it so that you want to wake up later the next day. It's not just because you're tired, it's because you shifted your clock with activity and temperature.

Visualization

Many people ask me about subjective tools for plasticity. What about visualization? You know, can we just imagine doing a particular activity? Will that help us get better at that activity? There's some evidence that visualization can do that. It's true. But here's the important distinction and here's why I personally don't do much deliberate visualization. First of all, I get my best ability - or achieve my best ability to visualize things - when I'm in kind of a sleepy state. I don't know why, but that's when I'm able to direct my brain towards internal visualization with my eyes closed. And generally, I fall asleep and I can't remember anything that I was thinking about before. Some people - and these are work that was done many years ago by Roger Shepard and by others - Roger was at Stanford, but in other labs have done this too, of course - of rotating objects physically in their mind as a way of improving or looking at the speed of spatial calculations and so forth. Some people are very good at visualization. They can close their eyes and they can just see objects and rotate them deliberately, etc. A lot of people - like me - when we start doing that, our mind drifts too easily. But I like to think I'm a reasonably focused person in the waking state. So, visualization has - it's interesting because I think people are very attracted to the idea that they can just think about something and then get better at it that way and it's probably true if you can be very linear in the way that you visualize things. So, I want to repeat that. I think visualization does have certain power if you can remain very linear, and deliberate, and focused in the visualization. But many people - like myself - who are challenged with maintaining that linear focus with eyes closed and in visualization, they don't get much out of visualization. And I think the data on performance really supports that. Now there are examples where, for instance, people will injure one limb and then they will exercise the intact limb - or the non-injured limb rather - and they will visualize the opposite limb. Sometimes, there's even the use of mirror boxes so that - let's say, my left limb is injured - I'm maintaining activity with my right limb - but I'm using a mirror box so it looks like my left limb is working well. Yes, there's some top-down or feedback mechanisms that support the idea that the injured limb can rehabilitate more quickly, etc. But those are fairly elaborate schemes. These aren't the kinds of - I don't have mirror boxes around my house. I - I think these are specialized circumstances. They're a little bit like the - the examples that we see in the news where, "Oh, so-and-so has a stroke and then spontaneously speaks a new language." I - I don't know what the answer to that is. I - it shows that the brain has associative networks that are typically suppressed and those can be unleashed, but you certainly don't want to go out and give yourself a stroke deliberately to try and unmask some skill because there's just no - there's no concrete way to go about that - in a way that you could really know that you were going to offset the detrimental effects of the stroke. In fact, I think it would be a terrible idea. So, I think what I'm trying to describe is how a typical - I don't know if I'm typical or normal - I mean, I've been told otherwise - is certainly not normal. But in terms of the way that I structure my day, I think that's normal. That's pretty normal. I tend to wake up right around - I don't know - somewhere between 5:30 and 7am depending on what I've been doing the night before. I tend to go to sleep somewhere around 10:30-11. I tend to have one bout in the morning where I can do really focused hard work and I can really activate the "go" pathway while also activating the "no-go" pathway so that I can really stay focused - but I rely on some tools. I have a period in the afternoon where I get sleepy and kind of out of it - like I think most people. And I tend to come out of that with an - recognizing the opportunity of that slightly sleepy

state for creative work and for thinking about things in novel ways. I get light a couple times a day. I eat low-carb during the day and I eat - I don't say high - but you know, higher carb. I eat starches in the evening - so, in a way I can sleep. And then, I really anticipate that late-afternoon peak in alertness - excuse me, late-night peak in alertness - that many people confuse for insomnia or challenges when actually, they're really quite normal in their circadian cycle. And then, I fall asleep and if all goes well, I stay asleep for 4 or 5 hours - typically it's 3 or 4 and then I wake up. I think I'm like most people, I wake up during the middle of the night.

Waking Up in the Middle of the Night

Now, one thing that I don't think has been discussed a lot, but one of my colleagues at the Stanford Sleep Lab tells me is that every hour and a half or so we all wake up. Some of you even look around believe it or not and go right back to sleep and you don't recognize it. Waking up periodically during sleep is the norm. It is not abnormal. I don't know why this has been discussed more prominently. I tend to wake up and if there's a bright light coming through the blinds or if there's some noise upstairs - if Costello's snoring particularly loud - I might get up. I might go use the restroom. I might pick up a book and read under low light or something and then I generally fall back asleep and wake up - typical time for me again - 5:30-7am in the morning. This waking up in the middle of the night thing - as I mentioned at the beginning of the podcast episode today - is not necessarily abnormal. What it probably reflects is that the real time - meaning the time that I should go to sleep - is probably closer to 8 o'clock. The word "midnight" was literally supposed to mean "mid night". We - many - meaning all of us - were meant to go to sleep and wake up with the rise - you know - with the setting and rising of the sun. And we know this because this beautiful study from University of Colorado where they took people out into the wilderness to reset their circadian clocks by way of - you know - measured by way of melatonin and cortisol - and they had them - they were completely out of whack from interacting with screens and staying up too late, etc. - and they basically had them view the sunrise and view the sunset each evening and almost all of them - not all of the students - but all of them got onto a schedule where they naturally wanted to go to sleep at sunset and wake up around sunrise - or just before sunrise - even when they were brought back into a normal artificial light setting. So, I think that's the natural pattern and we've just deviated from it with artificial lights. So, waking up at 3am or 4am doesn't necessarily mean that there's something screwed up about you - it - or that - you know - you have anxiety or something - although you might. They - what it likely means is that you were supposed to go to bed much earlier and because of this asymmetry in the autonomic nervous system where it's much easier for us to push and to delay our sleep time than it is to accelerate our wake up time, - in other words, it's easier to stay up and hang out at the party - even if you don't want to be there - then it is to wake up when you're exhausted and you're fast asleep. Most people are pushing through into the late hours of the evening and night and going to bed much later than they naturally would want to. And so, I personally don't want to go to bed at 8pm. A lot of good things happen between 8pm and 11pm. And so, I want to enjoy those and I push through the evening hours. But as a consequence, I'm running out of melatonin. My melatonin release is basically subsided by about 3 or 4am and so it makes sense that I would wake up. I don't take melatonin for reasons discussed in previous episodes. I do rely on things like magnesium glycinate or magnesium threonate - things like theanine. I'm not saying any of you need

to take those. That's just what I happen to take in order to facilitate my sleep and it's been a great benefit to me.

If I wake up in the middle of the night and I'm anxious for whatever reason and my mind is looping, I have a couple rules. One is I don't trust anything I think about when I wake up in the middle of the night - any of it - unless I've had a magnificent dream and I want to write it down. I'll do that every once in a while. Typically when I go back and read it, it's not at all magnificent. I can't ever remember coming up with anything really fantastic in one of my dreams that stuck with me or that I implemented. I don't really trust the kind of thinking that happens in those wee hours of the circadian cycle for me. It's just nothing either for me terribly creative or worth linear implementation at that time. One thing that has been very helpful is to sometimes do one of these non-sleep, deep rest protocols as a way to go back into sleep. So, a hypnosis app, or some of the scripts by Michael Sealey that I've mentioned before, or the Reveri Health, or yoga nidra protocol - those for me have been very useful at helping me turn off looping thinking in the middle of the night and fall back asleep.

Huberman Schedule

In reviewing my schedule for you, just as a context for how to implement certain types of tools for optimizing learning, realize that it gives the impression that there's a 90-minute bout of learning and work in the morning and then a 90-minute bout of creative type work in the afternoon and that's it. There are a lot of hours in between, of course. And I just want to be very clear, those hours - for me - are occupied by pretty - not mundane tasks - but things that are kind of random. Those are things like email, or attending to Zoom meetings, or meeting with colleagues and students, and things of that sort. I sometimes will read just for sake of my own enrichment. I mentioned those two 90-minute bouts because those are the two 90-minute bouts where I'm trying to expand on the mental capacities that I already have. They're really where I'm trying to stretch and grow what I'm able to do on a regular basis reflexively. So, I want to emphasize that. The whole day doesn't just consist of those two 90-minute bouts. That's not the way my schedule works and that's not the way my lifestyle is arranged - which is fortunate because I enjoy all those other things as well. And so, for many of you out there - who are in school, or have family demands, or other demands - the key is to slot in those brain optimization segments of about 90-minutes - one, or two, or maybe more per day - you're trying to slot those in wherever you can amidst your other obligations and things that you need to do. But you want to do that in an intelligent way that's anchored to your biology and then you want to do a number of things - which I've talked about today - in order to optimize those sessions to get the most out of them.

So, as we round up, I acknowledge that once again I've covered a huge range of topics related to how to optimize learning, and brain change, and essentially mental performance. And I've set that in the context of some biological mechanism like the basal ganglia, "go"/"no-go" pathways, the circadian autonomic system, and some of the relationship between food, and fasting, and particular types of food, and alertness or sleepiness. A linear focus and strategy implementation is best served by high alert states - although not too alert. And how creative states - at least the first

phase of creativity - which is the creative arrangement - kind of brainstorming stage - is supported by states of relaxation or even slightly sleepy. But the creative implementation is a very linear, and focused, and deliberate process - much like the highly focused state that I described. I described how I do these things, just to give you a context. A lot of you ask for what I do in order to set it within a context, but by no means are these rigid times and ways of doing things. But, I think it's fair to say that what I do has a circadian logic. It also has grounding in biological mechanisms that are very concrete - that we know the cells, and mechanisms, and neurotransmitters. And then, some of them are a little bit headed out into the what we would call kind of emerging - or, you know - I don't want to say cutting edge - but maybe front edge of what neuroscience is starting to understand about creativity and so forth. Those are areas that are just now coming to some clarity. And there's certainly is still a lot more work to do. A lot of different ways to arrange one's routine, but hopefully the tools and practices I described will be useful to you.

Tools / Practices

I want to mention that a lot of people ask me about specific tools and practices. They ask me about Wim Hof breathing, about ice bath - I've talked a little bit about ice baths before - I think in cold exposure - about binaural beats and things of those sorts. I think the way to look at any tool to modulate or measure the nervous system is ask whether or not it's going to move you up or down the state of autonomic arousal - whether or not it's going to make you more alert or more calm - more focused or something. That's kind of the two axes here that we need to think about. Sometimes you want to be more alert than you are and indeed, things like cold showers, ice baths, super oxygenation, Wim Hof type breathing will bring your level of alertness up. There's some cautionary notes associated with each of those. You need to read and understand those cautionary notes for yourself. Everybody's different and some of those carry certain dangers under certain conditions. Others have huge margins for safety. An ice bath generally wakes you up. A warmer hot bath generally calms you down, right? Binaural beats - there aren't a lot of data in quality peer-reviewed journals. I did put in the effort to go search it out. There are a few. Binaural beats - or listening to frequencies of sound that slightly differ or offset for the two ears - it has been shown can shift the brain into particular states. You'll notice today I didn't really talk about alpha, or theta, or gamma rhythms. I - I personally, in reviewing the literature, I don't think it's fair to say that alpha states are great for x and theta states are great for y. And besides, most of us aren't walking around our homes and our workplaces geared up to EEG machines or with wires down below our skull, so we don't know when we're in those states anyway. I think the subjective reading of whether or not one is alert or calm - and whether or not that alertness or calmness matches the goal or the thing that we're trying to achieve in terms of learning - including sleep - is the most valuable internal tool and recognition that we can all have. In other words, if I want to be very alert, and I need to be very alert, and I'm exhausted, there might be tools that I should use to wake up. It might also speak to the fact that I might not have slept as - as well as I could have - or should have - the night before. So, it's really about a match between where we are on that autonomic arousal scale and what we're trying to achieve. And indeed, there are going to be a lot of tools - including supplements, and other prescription drugs, and things - that can help move us along that autonomic continuum - up toward more alertness or toward more calmness. But ultimately, it's about tailoring that alertness and

calmness to the specific types of learning and activities that you are going to do and perform. And it's reciprocal - meaning some of those activities, like exercise early in the day, will increase your level of autonomic arousal and alertness. Certain foods will tend to wake you up. Certain foods will tend to make you more sleepy - and the volume of food and the timing of food is a factor also. So, it's a huge parameter space. It's a huge set of variables that impacts whether or not we're feeling well, performing well, learning great, or not learning great. And the key thing is to become an observer of your own system and what works for you and to recognize that there are two bins of tools for optimizing learning and brain performance. One, are tools that are really anchored in biological mechanism and we are certain of what those are - and I've talked about some of those. The other - the more subjective tools - for some of you, visualization might work terrifically well. For some of you, one song might really wake you up because of the associations you have with it. And for me, I might just - you know - it might repel me from the room because I don't like it or it might put me to sleep. But of course, volume is kind of a universal. Loud music tends to wake people up. Soft music doesn't tend to wake them up quite as much. So part of today is really getting you to think about - in a scientific way - in a structured way - about the non-negotiable elements - which are that you're going to have a period of every 24-hour cycle when you tend to be more awake and a period when you tend to be more asleep. And how to leverage those so you're not fighting an uphill battle to wake up when you actually would want to be and should be sleepy - and not trying to go to sleep when you are naturally - you know - going to be most awake. So, a lot of it is - really anchors back to those core mechanisms of biology. And then, you start layering on the different protocols of food and supplementation, etc.

Natural Inclinations

And I think it's important to recognize that some people are just more go, go, go, go, go, and no-go. And some people are just calmer and have a harder time getting into action and inactivity. It's just the way that we're wired. Some of us have autonomic nervous systems that are more geared towards parasympathetic calm states. One of the reasons I love bulldogs - not just my bulldog - is that they are very calm animals. In fact, they make no spontaneous movements unless there's something to respond to. And I find that incredibly relaxing. Other animals like pit bulls - who I also really like and enjoy - and other species - their tail is always wagging and that they're always in a position to make a movement at any second because they tend to ride at pretty high levels of autonomic arousal. They pop up really quickly when you say it's time to go for a walk. Costello does it one limb at a time and sometimes he just goes back to sleep. And so, that - there are people like that too. And so, you have to know where you are and what particular goals you're trying to pursue.

Conclusion

As a final closure to this, I want to emphasize that today, as always, I've strived to be accurate. I'm sure if I made mistakes, some of you will point it out and I appreciate that and I'll post a correction if we agree that I indeed misspoke or miscited something. But by no means was I exhaustive. I mean, I might have exhausted some of you, but the information wasn't exhaustive - meaning there's no way that I could cover all the ways in which we optimize or can optimize learning and performance. I

think we've touched on a number of them that I hope that you'll find value in and that you'll explore in your own lives.

We are continuing with this theme because that's what we do for this podcast. We stand on one theme for an entire month. For the next episode, we're going to explore two very essential aspects of neuroplasticity that actually relate to learning - which are pain, pain management, and neural regeneration. And for those of you that don't have injuries or don't suffer from chronic pain, the discussion is still going to be a very important one because it's not just going to be about pain that you're trying to get rid of. It's also going to be about how certain sensory experiences within the pain network can become amplified, as well as how we can use top-down modulation. We can use our mind to suppress the pain response. We're also going to talk about some of the hardwired mechanisms that are bottom-up - that exist in our periphery and our body to control pain. We're also going to discuss a number of interesting interactions between the pain system and the learning system. Again, if you're not interested in pain per se, it still is going to be a very valid conversation for sake of understanding how to optimize brain performance. And neural regeneration goes hand-in-hand with that discussion. So, I hope you'll join us for that.

I suppose I'd be remiss if I didn't mention that Costello has been storing extremely loudly today. A good long walk this morning - which means up the driveway, down the driveway. He's an old dog. So, if you've been hearing him in the background and it's been distracting, now you know why. It probably relates to where you were on your level of autonomic arousal, and I'll leave it to you to answer that question for yourself.

Many of you continue to graciously ask how you can help support the podcast. And we really appreciate the question. The best way is to subscribe wherever it is you happen to be listening or watching. So, for those of you that it's YouTube, please subscribe to the YouTube channel. If it's Apple, subscribe to the podcast on Apple. Or if it's Spotify, subscribe there - maybe you subscribe to all three. If you have comments and feedback for us - suggestions for future podcast episodes or topics to cover - please place those in the comment section on YouTube. Apple also provides a section where you can give us a rating. We would love it if you give us a five star rating or whatever it is that you feel that we deserve. And in general, if you could tell people about the podcast - we hope that you would tell them because you think the information would be of use to them, of course. Tell your friends, tell your family, tell your co-workers - because as we expand the podcast, the support for the podcast just grows along with it. So, that's a terrific way to support us. As always, check out our sponsors, which were mentioned at the beginning. And in addition to that, we've now set up a Patreon account. Some of you asked specifically how you can help support the podcast, but you weren't interested in our sponsors or you were already engaged with our sponsors. So, we have a Patreon account. You can find it at patreon.com/andrewhuberman. Finally, in previous episodes today and in future episodes, I mentioned supplements. Supplements are one way - certainly not the only way - but they're one way in which we can modulate our nervous system for sake of better sleep, learning, alertness, and several other things as well. If you're interested in supplements, we've partnered with Thorne, T-H-O-R-N-E, because Thorne supplements have very high stringency in terms of what's in the bottle, the amounts of the substances that are in each

capsule or pill, etc. And they have partnered with other groups - such as the Mayo Clinic, all the major sports teams - so there's very high rigor associated with Thorne, which is why we've decided to partner with them. If you'd like to check out Thorne supplements and see the supplements that I take, you can go to Thorne, [T-H-O-R-N-E.com/u/huberman](https://www.thorne.com/u/huberman), and you'll see a list of some of the supplements that I take. As well, you'll get 20% off any of the supplements listed there, as well as anywhere else on the Thorne website. So, that's Thorne, [T-H-O-R-N-E.com/u/huberman](https://www.thorne.com/u/huberman) for 20% off any Thorne supplements. Last but not least, on behalf of me and Costello, I want to thank you for your time and attention today. And as always, thank you for your interest in science.