

Huberman Lab #5 - Understanding and Using Dreams to Learn and to Forget

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Introduction

Welcome to the Huberman Lab Podcast where we discuss science and science-based tools for everyday life. I'm Andrew Huberman and I'm a professor of neurobiology and ophthalmology at Stanford School of Medicine. This podcast is separate from my teaching and research roles at Stanford. It is, however, part of my desire to bring 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.

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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 and I started using it because I had a lot of confusion about what vitamins and minerals I should take. Taking Athletic Greens allowed me to get the foundation or sort of the base of everything I need in one easy-to-consume formula. It tastes great. I mix mine with water and a little bit of lemon juice and I like drinking it. And the probiotics in there are important to me as well because there are a lot of data out there now identifying the gut microbiome and the importance of the gut brain axis and for immune function, metabolic function and so forth. If you want to try Athletic Greens, you can go to athleticgreens.com/huberman and if you do that, they'll also send you a year's supply of liquid vitamin D3K2. There are a lot of data starting to surface about the importance of vitamin D3 for immune function, metabolic function, endocrine function and so forth. In addition, if you go to athleticgreens.com/huberman, you'll get the year's supply of D3 and K2 as well as five free travel packs - which are little packets of athletic greens in addition to your normal order. And those are great for when you're on the plane or you're otherwise traveling. They mix up really easily without any mess or the need to spoon out powder and things of that sort. So, the things that are easy to do at home are kind of harder on the road. Those packets make it easy while on the road.

Today, we're going to talk about dreaming, learning during dreaming and unlearning during dreaming - in particular, unlearning of troubling emotional events. Now, my interest in dreaming goes way back. When I was a child, I had a friend and he came over one day and he brought with him a mask that had a little red light in the corner. He had purchased this thing through some magazine ad that he had seen. This mask was supposed to trigger lucid dreaming. Lucid dreaming is the

experience of dreaming during sleep, but being aware that one is dreaming and in some cases, being able to direct one's dream activities. So, if you're in a lucid dream and you want to fly, for instance, some people report being able to initiate that experience of flying. Or to contort themselves into an animal or to transport themselves to wherever they want within the dream. I tried this device. The way it worked is you put on the mask during a waking state - wide awake - and you'd look at the little light flashing in the corner. And then, you'd also wear it when you went to sleep at night. And indeed, while I was asleep, I could see the red light presumably through my eyelids. Although, for all I know, I had opened my eyes. I don't know. I was asleep. And then, because I was dreaming and I was experiencing something very vivid, I was able to recognize that I was dreaming and then start to direct some of the events within that dream. Now lucid dreaming occurs in about 20% of people. And in a small percentage of those people, they lucid dream almost every night. So much so that many of them report their sleep not being as restorative as it would be otherwise.

Now, all of this is to say that lucid dreaming and dreaming are profound experiences. We tend to feel extremely attached to our dream experience. This may explain the phenomenon of people who have a very intense dream. They need to somehow tell everybody about that dream or tell someone about that dream. I don't really know what that behavior is about. But sometimes we wake up and we feel so attached to what happened in this state that we call dreaming that there seems to be an intense need to share it with other people - presumably to process it and make sense of it. Now, numerous people throughout history have tried to make sense of dreams in some sort of organized way. The most famous of which is of course is Sigmund Freud who talked about symbolic representations in dreams. A lot of that has been kind of debunked. Although, I think that there's some interest in what the symbols of dreaming are. And this is something that we'll talk about in more depth today - although not Freudian theory in particular.

Physiology of Sleep

So, I think in order to really think about dreams and what to do with them and how to maximize the dream experience for sake of learning and unlearning, the best way to address this is to look at the physiology of sleep - to really address: What do we know concretely about sleep? So, first of all, as we get sleepy, we tend to shut our eyes and that's because there are some autonomic centers in the brain - some neurons that control closing of the eyelids when we get sleepy. And then, we transition into sleep. And sleep, regardless of how long we sleep, is generally broken up into a series of 90-minute cycles - these ultradian cycles. So, early in the night, these 90-minute cycles tend to be comprised more of shallow sleep and slow-wave sleep. So, stage 1, stage 2, etc. and what we call slow-wave sleep. I'll go into detail about what all this means in a moment. And we tend to have less so-called REM sleep, R-E-M sleep, which stands for rapid eye movement sleep. And I'll talk about rapid eye movement sleep in detail. So, early in the night, a lot more slow-wave sleep and less REM. For every 90-minute cycle that we have during a night of sleep, we tend to start having more and more REM sleep. So, more of that 90 minute cycle is comprised of REM sleep and less of slow-wave sleep. Now, this is true, regardless of whether or not you wake up in the middle of the night to use the restroom or your sleep is broken. The more sleep you're getting across the night, the more REM

sleep you're going to have. And REM sleep and non-REM, as I'll refer to it, have distinctly different roles in learning and unlearning. And they are responsible for learning and unlearning of distinctly different types of information. And this has enormous implications for learning of motor skills, for unlearning of traumatic events, or for processing emotionally challenging, as well as emotionally pleasing events. And as we'll see, one can actually leverage their daytime activities in order to access more slow-wave sleep or non-REM sleep, as we'll call it, or more REM sleep, depending on your particular emotional and physical needs. So, it's really a remarkable stage of life that we have a lot more control and power over than you might believe. We'll also talk about lucid dreaming. We're also going to talk about hallucinations and how drug-induced hallucinations have a surprising similarity to a lot of dream states and yet some really important differences.

Slow-Wave Sleep / Non-REM Sleep

Okay, so let's start by talking about slow-wave sleep or non-REM sleep. Now, I realize that slow-wave sleep and non-REM sleep aren't exactly the same thing, so for you sleep aficionados out there, I am lumping right now. As we say in science, there are lumpers and there are splitters, and I am both. Sometimes I lump, sometimes I split. For sake of clarity and ease of conversation right now, I'm going to be a lumper. So, when I say slow-wave sleep, I mean non-REM sleep generally - although I acknowledge there is a distinction. Slow wave sleep - so, slow-wave sleep is characterized by a particular pattern of brain activity in which the brain is metabolically active, but that there's these big sweeping waves of activity that include a lot of the brain. If you want to look this up, there - you can find evidence for sweeping of waves of neural activity across association cortex, across big swaths of the brainstem - the so-called pons-geniculate-occipital pathway. This is brainstem, thalamus, and then cortex - for - for those of you that are interested - although more of that is going to occur in REM sleep. Now, the interesting thing about slow-wave sleep are the neuromodulators that tend to be associated with it - that are most active and least active during slow-wave sleep. And here's why. To remind you, neuromodulators are these chemicals that act rather slowly, but their main role is to bias particular brain circuits to be active and other brain circuits to not be active. These are like the music playlists. So, think of neuromodulators - and these come in the names of acetylcholine, norepinephrine, serotonin, and dopamine - think of them as suggesting playlists on your audio device. So, classical music is distinctly different in feel, and tone and a number of other features from like third wave punk or from - you know - hip hop, right? So, think of them as biasing toward particular genres of neural circuit activity - mellow music versus really aggressive fast music - or rhythmic music that includes lyrics versus rhythmic music that doesn't include lyrics. That's more or less the way to think about these neuromodulators. And they are associated as a consequence with certain brain functions. So, we know, for instance, and just to review acetylcholine in waking states is a neuromodulator that tends to amplify the activity of brain circuits associated with focus and attention. Norepinephrine is a neuromodulator that tends to amplify the brain circuits associated with alertness and the desire to move. Serotonin is the neuromodulator that's released and tends to amplify the circuits in the brain and body that are associated with bliss and the desire to remain still. And dopamine is the neuromodulator that's released and is associated with amplification of the neural circuits in the brain and body associated with pursuing goals, and pleasure and reward, okay? So, in slow-wave sleep, something really

interesting happens. There is essentially no acetylcholine. Acetylcholine production, and release and action from the two major sites - which are in the brain stem - which from a nucleus - if - it's a parabrachial nucleus (PBN) - if you really want to know. Or from the forebrain, which is nucleus basalis. And you don't need to know these names, but if you like - that's why I put them out there. Acetylcholine production plummets. It's just almost to zero. And acetylcholine, as I just mentioned, is associated with focus. So, you can think of slow-wave sleep as these big sweeping waves of activity through the brain and a kind of distortion of space and time so that we're not really focusing on any one thing. Now, the other molecules that are very active at that time are norepinephrine - which is a little bit surprising because normally in waking states, norepinephrine is going to be associated with a lot of alertness and the desire to move - but there's not a ton of norepinephrine around in slow-wave sleep - but it is around. So, there's something associated with the movement circuitry going on in slow-wave sleep. And remember, this is happening mostly at the beginning of the night. Your sleep is dominated by slow-wave sleep. So, no acetylcholine, very little norepinephrine - although there is some - and a lot of serotonin. And serotonin, again, is associated with this desire - the sensation of kind of bliss or well-being - but not a lot of movement. And during sleep, you tend not to move. Now, in slow-wave sleep, you can move. You're not paralyzed. So, you can roll over. If people are going to sleepwalk, typically it's going to be during slow-wave sleep. And what studies have shown through some kind of sadistic experiments where people are deprived specifically of slow-wave sleep. And that can be done by waking them up as soon as the electrode recordings show that they're in slow-wave sleep or by a chemically altering their sleep so that it biases them away from slow-wave sleep.

What studies have shown is that motor learning is generally occurring in slow-wave sleep. So, let's say the day before you go to sleep, you were learning some new dance move, or you were learning some specific motor skill - either a fine motor skill or a coarse motor skill. So, let's say it's a new form of exercise or some new coordinated movements. This could be a coordinate movement at the level of the fingers or it could be a coordinate movement at the level of the whole body and large limb movements. It could involve other people or it could be a solo activity. Learning of those skills is happening primarily during slow-wave sleep in the early part of the night. In addition, slow-wave sleep has been shown to be important for the learning of detailed information. Now, this isn't always cognitive information. We're going to talk about cognitive information, but the studies that have been done along these lines involve having people learn very detailed information about very specific rules and the way that certain words are spelled. They tend to be challenging words. So, if people are tested in terms of their performance on these types of exams and they're deprived of slow-wave sleep, they tend to perform very poorly. So, we can think of slow-wave sleep as important for motor learning, motor skill learning, and for the learning of specific details about specific events. And this turns out to be fundamentally important because now we know that slow-wave sleep is primarily in the early part of the night, and motor learning is occurring primarily early in the night, and detail learning is occurring early in the night. Now, for those of you that are waking up after only 3-4 hours of sleep, this might be informative. This might tell you a little something about what you are able to learn and not able to learn if that were to be the only sleep that you get - although, hopefully that's not the only sleep that you get. But we're going to dive deep

into how it is that one can maximize motor learning in order to extract, say, more detailed information about coordinated movements and how to make them faster or slower. So, that might be important for certain sports. It might be almost certainly important for certain sports. It's going to be important for any kind of coordinated movement, like say learning to play the piano, or, for instance, how to learn synchronized movements with somebody else. So, maybe - I mentioned the example of dance earlier. If you - like me a few years ago, I set out to - to learn tango because I have some Argentine relatives and I was abysmal. I need to return to that at some point. The - I was just abysmal and one of the worst things about being abysmal at learning dance is that there's somebody else has to suffer the consequences also. So, I don't know, maybe in the month on neuroplasticity, I'll explore that again as a - as a self-experimentation. But the key things to know are slow-wave sleeps involved in motor learning and detailed learning. There's no acetylcholine around at that time. It has this big amplitude activity sweeping throughout the brain and that there's the release of these neuromodulators norepinephrine and serotonin. And again, that's all happening early in the night.

So athletes, people that are concerned about performance, if you happen to wake up after just a couple hours of - you know - of 3-4 hours of sleep because you're excited about a competition the next day. Presumably, if you've already trained the skills that you need for the event, you should be fine to engage in that particular activity. Now, it's always going to be better to get a full night sleep - and you know, if a full night sleep for - for you is 6 hours, then it's always going to be better to get more - more sleep than it is to get less. However, I think some people get a little bit overly concerned that if they didn't get their full night sleep before some sort of physical event, that their performance is going to plummet. Presumably, if you've already learned what you need to do, and it's stored in your neural circuits, and you know how to make those coordinated movements, what the literature on slow-wave sleep suggests is that you would be replenished - that the motor learning and the recovery from exercise is going to happen early in the night, okay? So, we'll just pause there and kind of shelve that for a moment, and then we're going to come back to it.

REM Sleep

But I want to talk about REM sleep or rapid-high movement sleep. REM sleep and rapid-high movement sleep - as I mentioned before - occurs throughout the night but you're going to have more of it - a larger percentage of these 90-minute sleep cycles is going to be comprised of REM sleep as you get toward morning. REM sleep is fascinating. It was discovered in the '50s when sleep laboratory in Chicago - the researchers observed that people's eyes were moving under their eyelids. Now, something very important that we're going to address when we talk about trauma later is that the eye movements are not just side-to-side, they're very erratic in all different directions. One thing that I don't think anyone - I've never heard anyone really talk about publicly - is: Why eye movements during sleep? Right? Eyes are closed and sometimes people's eyelids will be a little bit open and their eyes are darting around - especially in little kids. I don't suggest you do this. I'm not even sure it's ethical. But it has been done where you pull back the eyelids of a kid while they're sleeping and their eyes are kind of darting all over the place. I think people do this to their passed out friends at parties and things like that. So - again, I don't suggest you do it, but I tell you it

because it's been done before and therefore you don't have to do it again. But rapid eye movement sleep is fascinating and occurs because there are connections between the brainstem - an area called the pons - and areas of the thalamus and the top of the brainstem that are involved in generating movements in different directions - sometimes called saccades - although sometimes during rapid eye movement sleep, it's not just rapid. It's kind of a jittery side-to-side thing and then the eyeballs kind of roll. It's really pretty creepy to look at if you see. So, what's happening there is the circuitry that is involved in conscious eye movements is kind of going haywire. But it's not haywire. It's these waves of activity from the brainstem up to the so-called thalamus - which is an area that filters sensory information and then up to the cortex. And the cortex, of course, is involved in conscious perceptions.

So, in rapid eye movement sleep, there are a couple things are happening besides rapid eye movements. The main ones are that they're in contrast - I should say - they're in contrast to slow-wave sleep. In REM sleep, serotonin is essentially absent, okay? So, this molecule, this neuromodulator that tends to create the feeling of bliss, and well-being and just calm - placidity - is absent, alright? So, that's interesting. In addition to that, norepinephrine - this molecule that's involved in movement and alertness - is absolutely absent. It's probably one of the few times in our life that epinephrine is essentially at zero activity within our system. And that has a number of very important implications for the sorts of dreaming that occur during REM sleep and the sorts of learning that can occur in REM sleep and unlearning. First of all, in REM sleep, we are paralyzed. We are experiencing what's called atonia - which just means that we're completely laid out and paralyzed. We also tend to experience whatever it is that we're dreaming about as a kind of hallucination or a hallucinatory activity. Long ago, I looked into hallucinations and dreaming. I was just fascinated by this in high school. And there's some great books on this if you're interested in exploring the relationship hallucinations and dreaming - the most famous of which are from a guy - researcher at Harvard - Allan Hobson - wrote a book called "The Dream Drugstore" and talked all about the similarities between drugs that induce hallucinations and dreaming in REM. So, you can explore that if you like. So, in REM, our eyes are moving but the rest of our body is paralyzed and we are hallucinating. There's no epinephrine around. Epinephrine doesn't just create a desire to move an alertness. It is also the chemical signature of fear and anxiety. It's what's released from our adrenal glands when we experience something that's fearful or alerting. If a car suddenly screeches in front of us or we get a troubling text message, adrenaline is deployed into our system. Adrenaline is epinephrine. Those are equivalent molecules. Epinephrine isn't just released from our adrenals. It's also released within our brain. So, there's this weird stage of our life that happens more toward morning - that we call REM sleep - where we're hallucinating and having these outrageous experiences in our mind, but the chemical that's associated with fear, and panic and anxiety is not available to us. And that turns out to be very important. And you can imagine why that's important. It's important because it allow us - allows us to experience things - both replay of things that did occur as well as elaborate contortions of things that didn't occur - and it allows us to experience those in the absence of fear and anxiety. And that, it turns out, is very important for adjusting our emotional relationship to challenging things that happened to us while we were awake. Those challenging things can sometimes be in the form of social anxiety, or just having been working very

hard, or concerned about an upcoming event, or sometimes people report - for instance - dreams where they find themselves late to an exam, or naked in public, or in a - in some sort of situation that would be very troubling to them. And that almost certainly occurs during REM sleep. So, we have this incredible period of sleep in which our experience of emotion-laden events is dissociated. It's chemically blocked from us having the actual emotion.

Probably immediately some of you are thinking, "Well, what about nightmares? I have nightmares, and those carry a lot of emotion or sometimes I'll wake up in a panic." Let's consider each of those two things separately because they are important in understanding REM sleep. There's a good chance that nightmares are occurring during slow-wave sleep. There are actually some drugs that I don't suggest people take. In fact, so much so I'm not going to mention them - that give people very scary or eerie dreams and this kind of feeling that things are pursuing them or that they can't move when they are being chased. That's actually a common dream that I've had as I guess it's more or less a nightmare. The feeling that one is paralyzed and can't move and is being chased. A lot of people have said, "Oh, that must be in REM sleep because you're paralyzed and so you're dreaming about being paralyzed and you can't move." I think that's probably false. The research says that because norepinephrine is absent during REM sleep, it's very unlikely that you can have these intense fearful memories. Those are probably occurring in slow-wave sleep - although there might be instances where people have nightmares in REM sleep. The other thing is some people experience - certainly I've had this experience - waking up and feeling very stressed about whatever it was that I happen to be thinking about or dreaming about in the moments before. And that's an interesting case of an invasion of the dream state into the waking state and the moment you wake up, epinephrine is available. So, the research on this isn't fully crystallized but most of it points in the direction of - the experience of waking up and feeling very panicked may be - I want to highlight "may" - but may be that you were experiencing something that was troubling in the daytime. You're repeating that experience in your sleep. Epinephrine is not available and therefore the brain circuits associated with fear and anxiety are shut off and so you're able to process those events. And then, suddenly you wake up and there's a surge of adrenaline - of epinephrine - that's now coupled to that experience. So, nightmares - very likely in slow-wave sleep. And that kind of panic on waking from something - very likely to be an invasion of the thoughts and ideas - however distorted in REM sleep - invading the waking state. In fact, that brings to mind something that I've mentioned once before but I want to mention again. This atonia - this paralysis - that we experienced during sleep can invade the waking state. Many people report the experience of waking up and being paralyzed. They're legitimately waking up. It's not a dream - waking up and being paralyzed and it is terrifying. I've had this happen before. It is - I can tell you - terrifying - to be wide awake and as far as I could tell fully conscious but unable to move. And then, generally you can jolt yourself out of it in a few seconds but it is quite frightening. Now some people actually experience waking up, being fully paralyzed and hallucinating.

And there is a theory - in the academic and scientific community at least - that what people report as alien abductions have a certain number of core characteristics that map quite closely - eerily similarly - to these experiences. A lot of reports of alien abduction involve people being unable to

move, seeing particular faces, hallucinating extensively, feeling like their body is floating or they were transported. This is very similar to the experience of invasion of atonia into the waking state - waking up and still being paralyzed as well as the hallucinations that are characteristic of dreaming in REM sleep. Now, I'm not saying that people's alien abductions were not legitimate alien abductions. How could I? I wasn't there. And if I was there, I wouldn't tell you because that would make me an alien and I wouldn't want you to know. But it is quite possible that people are experiencing these things and they are an invasion of the sleep state into the waking state and they can last several minutes or longer. Because in dreams space and time are distorted, our perception of these events could be that they lasted many hours and we can really feel as if they lasted many hours when in fact they took only moments. And we're going to return to distortion of space and time in a little bit.

So, to just recap where we've gone so far, slow-wave sleep early in the night has been shown to be important for motor learning and for detail learning. REM sleep has a certain dream component when which there's no epinephrine, therefore we can't experience anxiety. We are paralyzed. Those dreams tend to be really vivid and have a lot of detail to them. And yet, in REM sleep, what's very clear is that the sorts of learning that happened in REM sleep are not motor events. It's more about unlearning of emotional events. And now we know why - because the chemicals available for really feeling those emotions are not present.

Now that has very important implications. So, let's address those implications from two sides. First of all we should ask what happens if we don't get enough REM sleep. And a scenario that happens a lot where people don't get enough REM sleep is the following. I'll just explain the one that I'm familiar with because it happens to me a lot - although I've figured out ways to adjust. I go to sleep around 10:30 - 11 o'clock. I fall asleep very easily and then I wake up around 3 or 4am. I now know to use a NSDR - a non-sleep, deep rest protocol - and that allows me to fall back asleep. Even though it's called non-sleep, deep rest, it - really allows me to relax my body and brain and I tend to fall back asleep and sleep until about 7am - during which time I get a lot of REM sleep. And I know this because I've measured it and I know this because my dreams tend to be very intense of the sort that we know is typical of REM sleep. In this scenario I've gotten my slow-wave sleep early in the night and I've got my REM sleep toward morning. However, there are times when I don't go back to sleep - maybe I have a flight to catch. That's happened. Sometimes I've got a lot on my mind and I don't go back to sleep. I can tell you and you've probably experienced that the lack of REM sleep tends to make people emotionally irritable. It tends to make us feel as if the little things are the big things. So, it's very clear from laboratory studies where people have been deprived selectively of REM sleep that our emotionality tends to get a little bit unhinged and we tend to catastrophize small things. We tend to feel like the world is really daunting. We're never going to move forward in the ways that we want. We can't unlearn the emotional components of whatever it is that's been happening - even if it's not traumatic.

The other thing that happens in REM sleep is a replay of certain types of spatial information - about where we were and why we were in those places. And this maps to some beautiful data and studies - that were initiated by a guy named Matt Wilson at MIT years ago - showing that in rodents - and it turns out in other non-human primates and in humans - there's a replay of spatial information during REM sleep that almost precisely maps to the activity that we experienced during the day as we move from one place to another. So, here's a common world scenario. You go to a new place. You navigate through that city or that environment. This place doesn't have to be - you know - at the scale of a city. It can be a new building. It can be a - finding particular rooms - new social interaction. You experience that and if it's important enough, that becomes solidified a few days later and you won't forget it. If it's unimportant, you'll probably forget it. During REM sleep, there's a - there's a literal replay of the exact firing of the neurons that occurred while you were navigating that same city or building earlier. So, REM sleep seems to be involved in the generation of this detailed spatial information.

But what is it that's actually happening in REM sleep? So, there's this uncoupling of emotion. But most of all what's happening in REM sleep is that we're forming a relationship with particular rules or algorithms. We're starting to figure out - based on all the experience that we had during the day - whether or not it's important that we avoid certain people or that we approach certain people - whether or not it's important that when we enter a building that we go into the elevator and turn left where the bathroom is, for instance - these general themes of things and locations and how they fit together. And that has a word. It's called "meaning". During our day, we're experiencing all sorts of things. "Meaning" is how we each individually piece together the relevance of one thing to the next, right? So, if I suddenly told you that this pen was downloading all the information to my brain that was important to deliver this information, you'd probably think I was a pretty strange character because typically we don't think of pens as downloading information into brains. But if I told you that I was getting information from my computer that was allowing me to say things to you, you'd say, "Well, that's perfectly reasonable." And that's because we have a clear and agreed upon association with computers and information and memory. And we don't have that same association with pens. You might say, "Well, duh." But something in our brain needs to solidify those relationships and make sure that certain relationships don't exist. And it appears that REM sleep is important for that.

Effects of REM Sleep Deprivation

Because when you deprive yourself or people of REM, they start seeing odd associations. They tend to lump or batch things. I know this from my own experience. If I've ever been sleep deprived - which unfortunately happens too often because of - I'm terrible with deadlines - it's - pull all-nighter - the word "the" starts to look like it's spelled incorrectly. And "the" is a very simple word to spell. But things start to look a little distorted. And we know that if people are deprived of REM sleep for very long periods of time, they start hallucinating. They literally start seeing relationships and movement of objects that isn't happening. And so, REM sleep is really where we establish the emotional load, but where we also start discarding of all the meanings that are irrelevant. And if you think about emotionality, a lot of over-emotionality or catastrophizing is about seeing problems

everywhere. And you could imagine why that might occur if you start linking the web of your experience too extensively. It's very important in order to have healthy emotional and cognitive functioning that we have fairly narrow channels between individual things. If we see something on the news that's very troubling, well then it makes sense to be very troubled. But if we're troubled by everything, and we start just saying, you know, "Everything is bothering me and I'm feeling highly irritable and everything is just distorting and troubling me." Chances are, we are not actively removing the meaning - the connectivity between life experiences as well as we could - and that almost always maps back to a deficit in REM sleep. So, REM sleep is powerful and has this amazing capacity to eliminate the meanings that don't matter. It's not that it exacerbates the meanings that do matter, but it eliminates the meanings that don't matter. And that bears a striking resemblance to what happens early in development. This isn't a discussion about early in development, but early in development the reason a baby can't generate coordinated movements and the reason why children can get very emotional about what seems like trivial events or what adults know to be trivial events like, "Oh, the ice cream shop is closed." And then, the kid just dissolves into a puddle of tears. And the parents can say, "Okay, well, it'll be open again another time." The - children - one of the reasons that they can't generate coordinated movement or place that event of the ice cream shop being closed into a larger context is because they have too much connectivity. And much of the maturation of the brain and nervous system that brings us to the point of being emotionally stable, reasonable, rational human beings is about elimination of connections between things. So, REM sleep seems to be where we uncouple the potential for emotionality between various experiences.

And that brings us to the absolutely fundamental relationship and similarity of REM sleep to some of the clinical practices that have been designed to eliminate emotionality and help people move through trauma and other troubling experiences - whether or not those troubling experiences are a death in the family or a close loved one, something terrible that happened to you or somebody else, or - you know - an entire childhood, or some event that in your mind and body is felt as and experienced as bad, terrible or concerning. Many of you perhaps have heard of trauma treatments such as EMDR - eye movement desensitization reprocessing - or ketamine treatment for trauma - something that recently became legal and is in fairly widespread clinical use. Interestingly enough, EMDR and ketamine - at kind of a core level - bear very similar features to REM sleep.

EMDR Therapy

So, let's talk about EMDR first. EMDR - eye movement desensitization reprocessing - is something that was developed by a psychologist Francine Shapiro. She actually was in Palo Alto. And the story goes that she was walking - not so incidentally in the trees and forests behind Stanford - and she was recalling a troubling event in her own mind. So, this would be from her own life and she realized that as she was walking, the emotional load of that experience was not as intense or severe. She extrapolated from that experience of walking and not feeling as stressed about the stressful event to a practice that she put into work with her clients - with her patients - and that now has become fairly widespread. It's actually one of the few behaviorally - the behavior treatments that are approved by the American Psychological Association for the treatment of trauma. What she had her

clients and patients do was move their eyes from side-to-side while recounting some traumatic or troubling event. Now this was of course in the clinic - and I'm guessing that she removed the walking component and just took the eye movement component to the clinic because while it would be nice to go on therapy sessions with your therapist and take walks, it has - there are certain boundaries to that such as confidentiality - you know, if there are a lot of people around - a person might not feel as open to discussing things - or weather barriers and things like - you know, if it's raining or hailing outside, it gets tough to do. Why eye movements? Well, she never really said why eye movements, but soon I'll tell you why the decision to select these lateralized eye movements for the work in the clinic was the right one. So, these eye movements, they look silly. I'll do them because that's why I'm here. They look silly, but they basically involve sitting in a chair and moving one's eyes from side-to-side - not while talking, but - you know - for me - you know - and then recounting the event. So, it's sometimes talking while moving the eyes. But usually it was moving the eyes from side-to-side for 30-60 seconds, then describing this challenging procedure. Now, as a vision scientist who also works on stress, when I first heard this, I thought it was crazy, frankly. People would ask me about EMDR and I just thought, that's crazy. I went and looked up some of the theories about why EMDR might work. And there were a bunch of theories, "Oh, it mimics the eye movements during REM sleep." That was one. Turns out that's not true, and I'll explain why. The other one was, "Oh, it synchronizes the activity on the two sides of the brain." Well, sort of. I mean - when you look into both sides of the binocular visual field, you activate the visual cortex. But this whole idea of synchrony between the two sides of the brain is something that I think modern neuroscience is starting to - let's just say - gently or not so gently - move away from - this whole "right brain/left brain" business. It turns out, however, that eye movements of the sort that I just did and that Francine Shapiro took from this walk experience and brought to the - her clients in the clinic are the sorts of eye movements that you generate whenever you're moving through space - when you are self-generating that movement. So, not so much when you're driving a car, but certainly if you were riding a bicycle, or you were walking or you were running. You don't realize that, but you have these reflexive subconscious eye movements that go from side-to-side and they are associated with the motor system. So, when you move forward, your eyes go like this. There have been a number of studies showing that these lateralized eye movements helped people move through or dissociate the emotional experience of particular traumas with those experiences such that they could recall those experiences after the treatment and not feel stressed about them or they didn't report them as traumatic any longer. Now, the success rate wasn't 100%, but they were statistically significant in a number of studies. And yet, there are still some critics of EMDR and frankly, for a long time, I still thought, "Well, I don't know, this just seems like kind of a hack. It just seems like - kind of a - this is something for which we don't know the mechanism and we can't explain." But in the last 5 years, there have been no fewer than 5 - and there's a 6th on the way - high-quality peer-reviewed manuscripts published in Journal of Neuroscience - Neuron - Cell Press journal, excellent journal - Nature, excellent journal. These are very stringent journals and papers showing that lateralized eye movements of the sort that I just did - and if you're just listening to this, it's just sweeping, moving the eyes from side-to-side with eyes open - that those eye movements, but not vertical eye movements - suppress the activity of the amygdala - which is this brain region that is involved in threat detection, stress, anxiety, and fear. There are some forms of

fear that are not amygdala-dependent. But the amygdala, it's not a fear center, but it is critical for the fear response and for the experience of anxiety. So, that's interesting. We've got a clinical tool now that indeed shows a lot of success in a good number of people - where eye movements from side-to-side are suppressing the amygdala - and the general theme is to use those eye movements to suppress the fear response and then to recount or repeat the experience - and over time, uncouple the heavy emotional load - the sadness, the depression, the anxiety, the fear - from whatever it was that happened that was traumatic. This is important to understand because - you know - I'd love to be able to tell somebody who had a traumatic experience that they would forget that experience. But the truth is you never forget the traumatic experience - what you do is you remove the emotional load. Eventually, it really does lose its potency. The emotional potency is alleviated. Now, EMDR - I should just mention - tends to be most successful for single-event or very specific kinds of trauma that happened over and over, as opposed to, say, an entire childhood or an entire divorce. They to be - it tends to be most effective for single-event kinds of things - car crashes, etc. - where people can really recall the events in quite a lot of detail. So, it's not for everybody and it should be done - if it's going to be done for trauma - it should be done in a clinical setting with somebody who's certified to do this. But that bears a lot of resemblance to REM sleep, right? This experience in our sleep where our eyes are movement - moving - excuse me - although in a different way. But we don't have the chemical epinephrine in order to generate the fear response and yet, we're remembering the event from the previous day or days. Sometimes in REM sleep, we think about things that happened a long, long time ago. So, that's interesting. And then now, there's this new treatment - this chemical treatment - with the drug ketamine, which also bears a lot of resemblance to the sorts of things that happen in REM sleep. Ketamine is getting a lot of attention now and I think a lot of people just don't realize what ketamine is. Ketamine is a dissociative anesthetic. It is remarkably similar to the drug called PCP - which is certainly a hazardous drug for people to use. Ketamine and PCP both function to disrupt the activity of a particular receptor in the brain called the NMDA receptor - N-methyl-D-aspartate receptor. This is a receptor that's in the surface of neurons or on the surface of neurons for which most of the time it's not active. But when something very extreme happens and there's a lot of activity in the neural pathway that impinges on that receptor, it opens and it allows the entry of molecules - ions - that trigger a cellular process that we call long-term potentiation. And long-term potentiation translates to a change in connectivity so that later, you don't need that intense event for the neuron to become active again. Let me clarify a little bit of this. The NMDA receptor is gated by intense experience.

One way you can think about this is typically I walk in my home. I might make some food and sit down at my kitchen table and I don't think anything about explosions. But were I to come home one night, sit down to a bowl of chicken soup and there was a massive explosion. The neurons that are associated with chicken soup in my kitchen table would be active in a way that was different than they were previously. And would be coupled to this experience of explosions such that the next time and perhaps every other time that I go to sit down at the kitchen table - no matter how rational I am about the origins of that explosion - maybe it was a gas truck that was down the road and there's no reason to think it's there today - but I would have the same experience. Those neurons

would become active and I'd get an increase in heart rate. I'd get an increase in sweating, etc. Ketamine blocks this NMDA receptor and prevents that crossover and the addition of meaning to the kitchen table, kitchen soup - excuse me - chicken soup / explosion experience. So, how is ketamine being used? Ketamine is being used to prevent learning of emotions very soon after trauma. So, ketamine is being stocked in a number of different emergency rooms where if people are brought in quickly - and - you know, these are hard to describe even - but - you know, a horrible experience of - you know, somebody seeing a loved one next to them killed in a car accident and they were driving that car. This isn't for everybody, certainly. And you need to talk to your physician. But ketamine is being used - so they might infuse somebody with ketamine so that their emotion is - it can still occur - but that the - that the plasticity - the change in the wiring of their brain - won't allow that intense emotion to be attached to the experience. Now, immediately you can imagine the sort of ethical implications of this, right? Because certain emotions need to be coupled to experiences. I'm not saying that people should be using ketamine or shouldn't be using ketamine - certainly not recreationally. It's quite dangerous. It does - it can be lethal and like PCP, it can cause pretty dramatic changes in perception and behavior. But in the clinical setting, the basis of ketamine-assisted therapies is really to remove emotion. And I think the way I've been hearing about it - talked in - about - in the general public - is a lot of people think it's a little bit more like the kind of psilocybin trials or the MDMA trials - where it's about becoming more emotional or getting in touch with a certain experience. Ketamine is about becoming dissociative or removed from the emotional component of the experience.

Ketamine Therapy

So, now we have ketamine, which chemically blocks plasticity and prevents the connection between an emotion and an experience. That's a pharmacologic intervention. We have EMDR, which is this eye movement thing that is designed to suppress the amygdala and is designed to remove emotionality while somebody recounts an experience. And we have REM sleep where the chemical epinephrine that allows for signaling of intense emotion and the experience of intense emotion in the brain and body is not allowed. And so we're starting to see an organizational logic - which is that a certain component of our sleeping life is acting like therapy. And that's really what REM sleep is about. So, we should really think about REM sleep and slow-wave sleep as both critical - slow-wave sleep for motor learning and detailed learning - REM sleep for attaching of emotions to particular experiences, and then for making sure that the emotions are not attached to the wrong experiences, and for unlearning emotional responses if they're too intense or severe.

And this all speaks to the great importance of mastering one's sleep - something that we talked about in episode two of the podcast and making sure that if life has disruptive events - either due to travel, or stress, or changes in school, or food schedule - something that we talked about in episodes three and four - that one can still grab a hold and manage one's sleep life. Because fundamentally, the unlearning of emotions that are troubling to us is what allows us to move forward in life. And indeed, the REM deprivation studies show that people become hyperemotional. They start to catastrophize. And it's no surprise, therefore, that sleep disturbances correlate with so many emotional and psychological disturbances. It's just - it - by now, it should just be obvious why that will be the case.

Menopause & the Brain

In fact, the other day I was in a discussion with a colleague of mine who's down in Australia, Dr. Sarah McKay. I've known her for two decades now from the time she was at Oxford. And Sarah studies - among other things - menopause and the brain. And she was saying that a lot of the emotional effects of menopause actually are not directly related to the hormones. There have been some really nice studies showing that the disruptions in temperature regulation in menopause map to changes in sleep regulation that then impact emotionality and inability to correctly adjust the circuits related to emotionality. And I encourage you to look at her work. We'll probably have her as a guest on the podcast at some point in the future because she's so knowledgeable about those sorts of issues as well as issues related to testosterone and in people with all sorts of different chromosomal backgrounds.

Appropriate Amount of REM Sleep & Slow-Wave Sleep

So, sleep deprivation isn't just deprivation of energy. It's not just deprivation of immune function. It is deprivation of self-induced therapy every time we go to sleep, alright? So, these things like EMDR and ketamine therapies are in clinic therapies, but REM sleep is the one that you're giving yourself every night when you go to sleep - which raises, I think, the other important question - which is: How to get and how to know if you're getting the appropriate amount of REM sleep and slow-wave sleep?

So, that's what we'll talk about next. So how should one go about getting the appropriate amount of slow-wave sleep and REM sleep and knowing that you're getting the right amount? Well, short of hooking yourself up to an EEG, it's going to be tough to get exact measurements of brain states from night to night. Some people nowadays are using things like the Oura ring, or a Whoop band or some other device to measure the quality, and depth and duration of their sleep. And for many people, those devices can be quite useful. Some people are only gauging their sleep by way of whether or not they feel rested - whether or not they feel like they're learning and they're getting better or not. There are some things that one can really do. And the first one is - might surprise you in light of everything I've said and probably everything you've heard about sleep. There was a study done by a Harvard undergraduate, Emily Hoagland - who was in Robert Stickgold's lab at the time. And that study explored how variations in total sleep time related to learning - as compared to total sleep time itself. And to summarize the study, what they found was that it was more important to have a regular amount of sleep each night as opposed to the total duration. In other words, and what they showed was that improvements in learning or deficits in learning were more related to whether or not you got 6 hours, 6 hours, 5 hours, 6 hours. That was better than if somebody got, for instance, 6 hours, 10 hours, 7 hours, 4 or 5 hours. You might say, "Well, that's crazy because I thought we're just all supposed to get more sleep and there's more REM towards morning." Turns out that for sake of learning new information and performance on exams in particular - that's what was measured - limiting the variation in the amount of your sleep is at least as important and perhaps more important than just getting more sleep overall. And I think this will bring people great relief - many people great relief who are struggling to quote unquote "get enough sleep". Remember a few episodes ago, I talked about the difference between fatigue and insomnia. You know, fatigue

tends to be when we are tired. Insomnia tends to lead to a sleepiness during the day when we're falling asleep. And you don't want that. You don't want either of those things, really. But I found it striking that the data from the study really point to the fact that consistently getting about the same amount of sleep is better than just getting more sleep. And I think nowadays, so many people are just aiming for more sleep and they're rather troubled about the fact that they're only getting 5 hours or they're only getting 6 hours in some cases. It may be the case that they are sleep deprived and they need more sleep. But some people just have a lower sleep need and I find great relief personally in the fact that consistently getting for me about 6 hours or 6 and a half hours is going to be more beneficial than constantly striving for 8 or 9 and finding that some nights I'm getting 5 and sometimes I'm getting 9 and varying around the mean. As I recall - and I think I'm going to get this precisely right - but if not, I know that I'm at least close - for every hour variation in sleep - regardless of whether or not I was more sleep than one typically got - there was a 17% reduction in performance on this particular exam type. And so, this is powerful. This means that we should strive for a regular amount of sleep. And for some of us, that means falling asleep and waking up and going back to sleep. For some people, it means falling asleep and waking up and not getting back to sleep. Now ideally, you're getting the full complement of slow-wave sleep early in night and sleep toward morning which is REM sleep - which brings us to how to get more REM sleep. Well, there are a couple of different ways.

How to Decrease REM Sleep

But here's how to NOT get more REM sleep, alright? First of all, drink a lot of fluid right before going to sleep. One of the reasons why we wake up in the middle of the night to use the bathroom is because when our bladder is full, there is a neural connection - literally a set of neurons in a nerve circuit that goes to the brainstem - that wakes us up. And actually some people that I know and won't be mentioned actually use this to try to adjust for their jet lag when they're trying to stay awake. Having to use the bathroom - having to urinate - is one of the most anxiety evoking experiences anyone can have. If you really have to go to the bathroom, it's very hard to fall asleep or stay asleep. And bedwetting, which happens in kids very early on, is a failure of those circuits to mature - to mature until - you know - I think we all assume that babies are going to pee in their sleep. But adults aren't supposed to do that. And the circuits take some time to develop and in some kids they develop a little bit later than others. So, having a full bladder is one way to disrupt your sleep. You don't want to go to bed dehydrated, but that's one way. On the other hand, there is evidence that if you want to remember your dreams more or remember more of your dreams, there is a tool that you can use. I don't necessarily recommend it - which is to drink a bunch of water before you go to sleep. And then, what happens is you tend to break in and out of REM sleep. It tends to be fractured. And with a sleep journal - then - they've done these laboratory studies, believe it or not. People will recall more of their dreams because they're in this kind of semi-conscious state because they're constantly waking up throughout the night. I suggest not having a full bladder before you go to sleep. That one's kind of an obvious one, but nonetheless. The other one is if you recall that during REM sleep, we have a shift in neurotransmitters such that we have less serotonin, right? Just want to make sure I got that right. Excuse me, less serotonin. There are a lot of supplements out there geared toward improving sleep. I've taken some of them - and I've

taken many of them - if not all of them at this point - so I could report back to you. And I think I mentioned in a previous episode that when I take tryptophan or anything that contains 5-HTP - which is serotonin - or precursor to serotonin - serotonin is made from tryptophan - I tend to fall very deeply asleep and then wake up a few hours later. And that makes sense now based on the fact that you just don't want a lot of REM sleep early on. What was probably happening is that I was getting a lot of REM sleep early on because low levels of serotonin are typically associated with slow-wave sleep and that comes early in the night. So, for some people, those supplements might work. But be aware serotonin supplements could disrupt the timing of REM sleep and slow-wave sleep and in my case, led to waking up very shortly after going to sleep and not being able to get back to sleep.

How to Increase Slow-Wave Sleep

Now, if you want to increase your slow-wave sleep, that's interesting. There are ways to do that. One of the most powerful ways to increase slow-wave sleep - the percentage of slow-wave sleep - apparently without any disruption to the other components of sleep and learning - is to engage in resistance exercise. It's pretty clear that resistance exercise triggers a number of metabolic and endocrine pathways that lend themselves to release of growth hormone, which happens early in the night. And resistance exercise, therefore, can induce a greater percentage of slow-wave sleep. It doesn't have to be done very close to going to bedtime. In fact, for some people that the exercise can be disruptive - for reasons I've talked about in previous episodes. But resistance exercise, unlike aerobic exercise, does seem to increase the amount of slow-wave sleep which - as we know - is involved in motor learning and the acquisition of fine detailed information - not general rules or the emotional components of experiences.

How to Lucid Dream

For those of you that are interested in lucid dreaming and would like to increase the amount of lucid dreaming that you're experiencing - I haven't been able to track down that device with the red light that I described at the beginning. But there are a number of just simple zero-technology tools that one could use in principle. One is to set a cue. The way this works is you come up with a simple statement about something that you'd like to see or experience later in dreams. You can, for instance, write down something like, "I want to remember the red apple." I know it sounds silly and trivial. And you look at that, you would probably want to write it down on a piece of paper. You might even want to draw a red apple. And then before you go to sleep, you would look at it and then you would just go to sleep. There are some reports that doing that for several days in a row can lead to a situation in which you are suddenly in your dream and you remember the red apple and that gives you a sort of tether to reality - between the dream state and reality - that allows you to navigate and shape and kind of adjust your dreams. Lucid dreaming does not have to be - or include the ability to alter features of the dream - to be able to control things in the dream - sometimes it's just the awareness that you are dreaming. But nonetheless, some people enjoy lucid dreaming. And then, for people that have a lot of lucid dreams that feel kind of overwhelmed by those, that's going to involve trying to embrace protocols that can set the right duration of sleep. There's a little bit of literature - not a lot - that shows that keeping the total amount of sleep per night to the - to

say 6 hours - such that you begin sleep and end at the beginning and end of one of these ultradian cycles can be better than waking up in the middle of one of these ultradian cycles. So, try and find the right amount of sleep that you need - that's right for you. And then, try and get that consistently night tonight. If you're a lucid dreamer and you don't like it, then you may want to start to make sure that you're waking up at the end of one of these ultradian cycles. So in this case, it would be better to wake up after 6 hours than after 7. And if you did sleep longer than 6 hours, maybe you'd want to get to 7 and a half hours because that's going to reflect the end of one of these 90-minute cycles as opposed to waking up in the middle.

Alcohol / Marijuana / L-arginine

Alcohol - alcohol and marijuana are well known to induce states that are pseudosleep-like - especially when people fall asleep after having consumed alcohol or THC - the active component - one of the active components in marijuana. Alcohol, THC, and most things like them - meaning things that increase serotonin or GABA - are going to disrupt the pattern of sleep. They're going to disrupt the depth. They're going to disrupt the overall sequencing of more slow-wave sleep early in the night and more REM sleep later in the night. That's just the reality. The - there are some things that - at least in a few studies that I could find - seem to suggest that you could increase the amount of slow-wave sleep using things like arginine - the amino acid L-arginine - although you really want to check. Arginine can have effects on heart, etc. - has other effects. But alcohol / THC - not going to be great for sleep and depth of sleep. You might feel like you can fall asleep faster, but the sleep that you're accessing really isn't the kind of deep restorative sleep that you should be getting. Now, of course, if that's what you need in order to sleep and that's within your protocols, I've said here before, I'm not suggesting people take anything. I'm not a medical doctor. I'm not a cop. So, I'm not trying to regulate anyone's behavior. I'm just telling you what the literature says.

Sleep Journal / Dream Journal

Some of you may want to explore your dreams, and meaning of dreams, etc. You know, there's not a lot of hard data about how to do this, but a lot of people report keeping a sleep journal or a dream journal can be very useful. They mark when they think they fell asleep the night before, when they woke up, and if they wake up in the middle of the night or early in the morning, they'll just write down what they can recall of their dreams. And even if they recall nothing, many people have the experience of mid-morning or later afternoon that suddenly comes to them that they had a dream about something and writing that down. I kept a dream journal for a while. It didn't really afford me much. I - I didn't really learn anything except that my dreams were very bizarre.

Theory of Mind

But there are some things that happen in dreams that are associated with REM sleep as compared to slow-wave sleep, which can tell you whether or not your dream likely happened in REM sleep or slow-wave sleep. And the distinguishing feature, it turns out, is something called theory of mind. Theory of mind is actually an idea that was developed for the study and assessment of autism. It was initially - that phrase "theory of mind" - was brought about by Simon Baron-Cohen, who is Sasha Baron-Cohen - the comedian's - brother. Simon Baron-Cohen is a psychologist - and to some extent - a neuroscientist at Oxford. And theory of mind tests are done on children. And the theory

of mind test is somewhat like the following. A child is brought into a laboratory and watches a video of a child playing with some sort of toy. And then, at the end of playing with that toy, they put the toy in a drawer and they go away. And then another child comes in and is looking around. And then, the experimenter asks the child who's in the experiment - the real child - and says, you know, "What does the child think? What are they feeling?" And most children of a particular age - 5, or 6 or older - will say, "Oh, he or she is confused. They don't know where the toy is." And they say something that implies what we call theory of mind, that they can put their ideas into - and their mind - into what the other child is likely to be feeling or experiencing. That's theory of mind. And it turns out that this is used as one of the assessments for autism because some children - not all - but some children that have autism or that go on to develop autism, don't have this theory of mind. They fixate on the fact that the first child put the toy in the drawer. They'll say, "It's in the drawer." as opposed to answering the question which is, "How does the second child feel about it?" or, "What are they experiencing?" So, theory of mind is something that emerges early in life as a part of the maturation of the circuits in the brain associated with emotional learning and social interactions. And we experience this in certain dreams. So, if you had a dream that you're puzzled about, or that you're fixated on and you're thinking about, you might ask, "In that dream, was I assessing somebody else's emotion and feeling, or was I very much in my own first-person experience?" And the tendency is that theory of mind tends to show up most in these REM-associated dreams. Now, this isn't a hard-and-fast rule, but chances are if you were in a dream and you were thinking about other people who wanted to do something to you - you were thinking about their desire to chase you, or help you, or something that was related to someone else's emotional experience - it was probably a REM dream. That dream occurred in rapid eye movement sleep as opposed to slow-wave sleep. And that makes sense when you think about the role of REM in emotional unlearning of associations with particular life events - that REM is rich with all sorts of exploration of the emotional load of being chased or the emotional load of having to take an exam the next day or being late for something. But again, if you're fixated or you can recall thinking a lot about or feeling a lot about what somebody else's motivations were, then chances are it was in REM. And if not, chances are it was in slow-wave sleep.

Summary

Today we've been in a deep dive of sleep and dreaming - learning and unlearning. And I just want to recap a few of the highlights and important points. A lot more slow-wave sleep in less REM early in the night - more REM and less slow-wave sleep later in the night. REM sleep is associated with intense experiences without this chemical epinephrine that allows us the anxiety or fear and almost certainly has an important role in uncoupling of emotion from experiences - self-induced therapy that we go into each night. That bears striking resemblance to things like EMDR, and ketamine therapies and so forth. Slow-wave sleep is critical, however. It's critical mostly for motor learning and the learning of specific details. So, REM is kind of emotions and general themes and meaning - and slow-wave sleep: motor learning and details. I personally find it fascinating that consistency of sleep - meaning getting 6 hours every night is better than getting 10 one night, 8 the next, 5 the next, 4 the next. I find that fascinating and I think I also like it because it's something I can control better than just trying to sleep more - which I think I'm not alone in agreeing that that's just hard for

a lot of people to do. This episode also brings us to the conclusion of a five episode streak where we've been focusing on sleep and transitions in and out of sleep - non-sleep, deep rest. We've talked about a lot of tools - morning light, evening light, avoiding lights, blue blockers, supplements, tools for measuring sleep duration and quality. We've been covering a lot of themes. I like to think that by now you're armed with a number of tools and information - things like knowing when your temperature minimum is, knowing when you might want to view light or not, when you might want to eat or take hot showers - or God forbid, a cold shower - something that most people, including me, more or less loathe but can have certain benefits - and that will allow you to shape your sleep life and get this consistent or more or less consistent amount of sleep on a regular basis. Nobody's perfect. In fact, I have this little joke that I sometimes tell. It's not funny - like most of the jokes I tell - I'm told they're not funny. But - you know - there's so much excitement now about intermittent fasting. Sometimes I think that someone should start something on intermittent sleep deprivation - although we're already doing that. We are all experiencing lack of sleep from time to time and I don't think we should catastrophize that too much. I think that what we want to do - rather than accumulate a sleep anxiety - is to - you know - if we get a bad night's sleep, we want to adjust. We want to get back on track and just get the consistent amount of sleep. Use those non-sleep, deep rest protocols to help us relax when we're feeling anxious or having trouble waking up in the middle of the night. There are a lot of tools out there and most of them are zero cost - and so I hope you'll find those beneficial.

Huberman's Dog - Costello

If you've been hearing Costello snoring throughout this episode, I apologize on his behalf. As I said in the welcome video to this podcast, he's an integral part of the podcast. A few people have said, "Hey, that noise in the background is really disruptive." Hey, what can I say? Costello is a 10-year-old bulldog mastiff. The lifespan on those animals is about 10 years. So, I'm not trying to make you feel guilty, but - you know - after he's gone, there won't be any snoring - although I'll probably get a different dog. So - sort of a - what would the kids say? "Sorry, not sorry"? Sorry, not sorry about the snoring. And I'm sorry if it's disruptive - genuinely - but he's here for the haul. So, that's what that's about.

A Look Ahead - Neuroplasticity

As we close out this segment on sleep, we are moving into a new theme and topic for the next four to five episodes. We are going to discuss the science and the tools related to neuroplasticity. Neuroplasticity is a remarkable feature of the nervous system. In fact, it's the defining feature of the nervous system - which is its ability to change itself in response to experience - that is unlike every other tissue and collection of cells and organ in our body. It's really what makes us "us" as a species, and it's what makes us "us" as individuals, and it's really where our potential lies. Everything that we know, everything we can do, and our true potential in terms of what we will ever be able to know, do, say in life is set by the limits of neuroplasticity. So, we're going to explore learning in childhood - learning in adulthood. We're going to discuss detailed protocols as they relate to sensory plasticity - learning new sensory information - versus motor plasticity - or sensory motor integration. We're going to talk about language acquisition. We're going to be talking about

emotional acquisition and breadth - as well as - I think, a topic a lot of people are going to find fascinating is - the relationship between plasticity set during childhood attachment to parent or other caregiver and how that maps onto adult relationships. There's many of you have probably heard about secure attach or insecure attach - the A, B and C babies as they're called - from the classic studies of Bowlby and others. But now, there's actual neuroscience that can say which circuits were active during those early life attachments and how those map to adult attachment styles, challenges, and what makes us more likely to select certain partners and styles of attachment - as well as how to change those. It's really fascinating and I think neuroscience's time has come for neuroplasticity. We're also going to talk, of course, about supplements, and chemicals, and machines and devices that can assist in speeding up the plasticity process. Or, believe it or not, there are some cases where you might want to delay plasticity in order to get more depth of learning and have that learning last longer - something that is just absolutely spectacular literature. So, I'm very excited to move on to that topic soon. I hope that the tools that you've acquired so far and the knowledge that you've acquired so far is helping you with your self-evaluation and experimentation as you see fit - and is allowing you to not just sleep better, but feel better while you're awake. And hopefully, I set the stage for you to learn better as we start to march into the month on neuroplasticity.

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Many of you have asked how you can help support the Huberman Lab podcast, and we greatly appreciate the question. You can help support the podcast by subscribing to the YouTube channel - if you haven't already - and leaving comments and questions in the comments section. If you could subscribe on Apple and/or Spotify, that's helpful. And there's a place on Apple podcast to leave a rating as well as comments about how you feel about the podcast. If you could suggest the podcast to friends, and coworkers and anyone else that you think would benefit from the information - that also really helps us get the word out. And of course, check out our sponsors because that's a very direct way to help us continue to get this information out to the general public. Many of you have asked about supplements and where I personally get my supplements. I've partnered with Thorne, and I get my supplements from Thorne because by my view, they have the highest level of stringency and precision in terms of what's in the bottle. And they also have very, very high quality standards. They're partnered with the Mayo Clinic and all the major sports organizations. If you want to try Thorne supplements, you can go to thorne.com. So, that's Thorne spelled T-H-O-R-N-E.com/u/huberman. And if you do that, you can see the formulations that I take and you'll also get 20% off - not just those formulations - but anything that Thorne makes. That's thorne.com/u/huberman to get 20% off anything they provide.

Corrections

Last but not least, a few people wrote to me with some questions/corrections about things that I said in previous podcasts. So, in keeping with my goal of making the information accurate and clear, I just want to correct myself about a few things that I said. One of those - and I'm guessing it probably came from an endocrinologist or somebody else that knows a lot about testicles - said, "Huberman, you mentioned that testosterone is made by the sertoli cells of the testes, and it's not.

It's made by the leydig cells of the testes - and indeed you are correct. And so, I want to make sure that I clarify that. Testosterone is made by the leydig cells of the testes, not by the sertoli cells. The sertoli cells make 5α -reductase, and aromatase and some other enzymes involved in conversion of testosterone into things like DHT and estrogen. So, thank you for that correction. I genuinely appreciate it. I misspoke. The other thing I said was at one point I said, "Typical temperature is 96.8" when I actually meant to say "98.6". So, it was a dyslexic slip on my part and I apologize. I don't know that I'm dyslexic. I - you know - I haven't been clinically diagnosed with dyslexia, but I swapped them - which sometimes happens when I'm going fast. So, I apologize. I'll use this as a moment to just say, temperature varies a lot across the day and night - that was a theme of previous podcasts. So, we can't really talk about average temperature anyway, but I do want to be clear that most people think about average temperature as 98.6. I misspoke - my error - and I apologize.

Conclusion

Thank you for joining me in this journey of the nervous system and biology and trying to understand the mechanisms that make us who we are and how we function in sleep and in wakefulness. It's really an incredible landscape to consider and I hope that you're getting a lot out of the information. As always, thank you for your interest in science.