TPWKY - EP 198 - Sleep Part 1

SRM: [00:00:00] Hey everyone, it's Stephen Ray Morris. I am here to tell you a little bit about sleep paralysis and lucid dreaming, and where the two meet in the middle, which is me. Sleeping has always been, or especially lately, has been pretty difficult, but for most of my life I've had pretty like stressful dreams to the point where I feel like sleep isn't very restful for me. When I was younger, it used to be really easy for me to fall asleep, but then the actual dreams and things themselves wouldn't be very restful and. That. I think like a common theme in my dreams is that I have to do a task in a limited amount of time and there's an obstacle getting in the way. And some of my favorite examples of this are I am like a manager at a brothel Christmas party and I have to make sure everybody gets their gifts, but all the gifts are unlabeled. I have to catch a train, but I keep running into people I haven't seen in a long time. So, oh hey, nice to see you. I actually, I gotta catch that train and then I run into somebody else. In college, I started getting sleep paralysis. I still do from time to time, but it was really bad where. You know, it's your, your brain is awake, but your body is asleep. So there's usually some sort of demon like nozzle, dementor style thing in the corner of the room, and it just causes this intense fear and terror. And so I usually wake up like everyone I've ever is, whatever spent the night with, have always. Had to deal with me waking up and screaming from these forces in college.

I met my roommate, my buddy Evan, who's from the Bay Area, and you know, we all watched Waking Life and in that movie they talk about lucid dreaming, which is, you know, the ability to be aware that you're dreaming and control your dreaming, et cetera, et cetera. The two main things that I took away from it are, you know, like AI look at your hands or look at clocks, because dreams can't represent either of those things very well. So if you see them, that means you know you're dreaming. So I'd started continuing these dreams where just this intense fear as this dark figure is looming in the corner and I. After all this lucid dreaming training or whatever, I started to like wriggle a little bit, you know, 'cause I was so scared that I like, was really trying to get away. And then one night, as it got right over my bed was looming down at me. I just remember this feeling of ah, you know, like full like superhero movie, like the Strain. And I, I reached my hand out and grabbed this sleep process demon by the wrist. And then I woke up and I didn't have sleep process again for a few years. I still remember this so clearly, like it was yesterday, even though this was maybe like, I don't know, almost 20 years ago. The sleep process still happens every once in a while, but I think my lucid dreaming training still serves me well occasionally. So I'm prepared. Basically anytime sleep paralysis, demons come at me.

EW: Steven,

EAU: Steven,

EW: I mean. First of all, terrifying. Yes. But also secondly, what a joy to hear your voice.

EAU: Oh, thank you so much for sharing your sleep And sleep dreams. Sleep paralysis stories with us.

EW: It is so scary. I've had sleep paralysis just a few times in my life. Yeah. And I truly thought I was dying.

EAU: I know.

I, I don't know that I've ever had it, but all of the stories that I hear are like really terrifying.

EW: Yeah, yeah.

EAU: Yeah.

EW: Oh, ha ha ha ha ha.

EAU: So

EW: yeah. Thank you.

EAU: Thank

EW: you. We appreciate it. Thank you. Hi, I'm Erin Welsh.

EAU: And I'm Erin Allmann Updyke

EW: And this is, This Podcast Will Kill You.

EAU: Welcome to the exactly right studios.

EW: Yes. Where we will be discussing in two episodes,

EAU: sleep.

EW: I'm excited for this.

EAU: Uh, very much so.

EW: Um, what are we gonna be talking about? There's a lot that we're gonna cover and a lot that we'll miss that we'll not cover. So we are gonna be talking, this first episode, we're focusing on what sleep is. Yeah. Essentially. Like what does it entail? What is your brain doing? Uh, a little bit about why sleep is important mm-hmm. Or what we think sleep is important for. Yeah. I'm gonna be talking about sleep in animals.

EAU: I'm so excited

EW: a lot. I'm really

EAU: excited about

EW: that. I'm excited [00:05:00] about it too. I did, did not know where it was gonna go.

EAU: Right.

EW: And then next episode we're gonna talk about some of the consequences of sleep deprivation. Yeah. And also we're gonna be talking about, um, the history of human sleep.

EAU: I'm really excited about that too.

EW: Yeah.

EAU: I think the second episode is gonna be a lot of interesting discussion about how we think about sleep today.

EW: I think so too. It. I, I personally felt a lot better about sleep.

EAU: Oh, good.

EW: Yeah.

EAU: That's great. At

EW: the end of it.

EAU: Happy to hear it.

EW: Thank you. Thank you.

EAU: Hopefully everyone else will

EW: too. Appreciate that.

EAU: But not this week.

EW: No.

EAU: This week you'll just learn a lot about sleep.

EW: Uh, yeah.

EAU: I'm excited.

EW: Um, and you'll also have a really delicious

EAU: beverage,

EW: beverage

EAU: to go along with it,

EW: right?

EAU: 'cause it's quarantining time.

EW: It is. In this case, it's placebo time. It is because alcohol spoiler alert, makes you sleep badly.

EAU: It's not good for your sleep. It's not good. Even though lots of people use it as a sleep aid.

EW: Oh, it's

EAU: bad. Or an anxiolytic.

EW: Mm-hmm.

EAU: Uh, it's not good for either of those.

EW: I mean, alcohol's not good for anything, period.

It's

EAU: not good for your body.

EW: Yeah. There's no safe amount. Anyway,

EAU: anyways,

EW: so we're, we're doing a placebo, Rita,

EAU: our placebo read is, is basically like a really nice version of a chamomile tea.

EW: But what is it called, Erin?

EAU: It's called Pillow talk. Pillow talk.

EW: Yeah.

EAU: The long pause of me trying to remember.

EW: Well, 'cause we had a few different options. We did. There was also bedtime story. Bedtime story. Yeah.

EAU: Which this what would work too.

EW: It's a great one. Yeah. Pillow talk. Pillow

EAU: talk.

EW: Yeah. It's a chamomile tea. Mm-hmm. Plus ginger honey syrup.

EAU: Yum.

EW: So good. A little and a little bit of lemon

EAU: in there.

EW: Yeah.

EAU: Kinda wish we had that to drink.

EW: That's so nice. It does. Sounds good For your throat. Yeah.

EAU: Yeah, yeah. Anyways, but you can make one and drink along with us. Mm-hmm. Mm-hmm. We'll post the full recipe on our social media channels for sure, at least.

EW: Mm-hmm.

EAU: Um, maybe on our website. Erin, walk us through the website.

EW: Oh, the website. Sorry

EAU: for throwing

EW: it up. What a treat. Yeah. The website is a real joy to discover. It's, you can find things like transcripts, you can find things like the sources for each and every one of our episodes. You can find links to our bookshop.org affiliate page. Goodreads List Merch. Mm. Some pretty sweet merch. Mm-hmm. Uh, you can find links to Music by Blood Mobile to a contact us form, a firsthand account form and probably some other things. There's an About Us page too.

EAU: There is. It's, it's got like four lines.

EW: Yep. It does not contain a lot of information.

EAU: Oh. So

EW: check that

EAU: out.

EW: Check it out.

EAU: Make sure you are rated. Rate it. Make sure you are rate, make sure you have subscribed and rate and if you'd like to and review rate and review, uh, the podcast. We would appreciate that.

EW: We're doing great.

EAU: We're really killing it today.

EW: Yeah.

EAU: Um, and if you are a fan of watching things, uh, we're on YouTube on the exactly right. Network

EW: channel. We're YouTube so you can see some sweet PJs that we're wearing.

EAU: We're pretty excited about

EW: this. I really like, I really like yours. Thank you. It's very Beetlejuice.

EAU: Love yours too. It is very Beetlejuice. Yeah.

EW: Thank you.

EAU: I love it. Um, we took a long time picking these out, everyone, so

EW: we did.

EAU: Okay. Well, with that, Erin,

EW: shall we take a break?

EAU: Business Completed,

EW: business complete.

EAU: Let's move on to learning about sleep.

EW: Love it.

EAU: Okay. We all sleep. All of us. Yeah. Humans.

EW: Mm-hmm.

EAU: And Erin, I know that you are gonna walk us through some of the many different ways that animals sleep, which I'm quite excited about. Like what does that mean in animals?

EW: What does it mean?

EAU: And there's such a variety there.

EW: What does it mean in humans?

EAU: Well, let me tell you about it. And that's an interesting question. It's because like, because we all sleep, I think that we all know what it means to sleep. One could even go so far as to say much like the Supreme Court Justice Potter Stewart said in 1964 when trying to define hardcore pornography. I know it. When I see it. Know

EW: it when you see it. Yep. Yep.

EAU: We all know what sleep is, but what is sleep? If we're trying to put like a label on it, what are our brains doing when we sleep? And these are the questions that I'm going to try and answer today. But the biggest question is one that we cannot really answer with what we know why. And that is why do we

EW: sleep?

EAU: Exactly.

EW: Yeah.

EAU: Why do we sleep? We don't really know truly the function of sleep, but we do have a lot of thoughts and hypotheses, which have various levels of support. So we'll get into some of that as well. And then next week, like we said, we'll talk more about what makes good sleep good, and what makes bad sleep bad.

EW: Ugh. It's so, and then what about like the quantities of sleep and all

EAU: of that stuff and the consequences? We'll get into all of that

EW: and architecture of sleep. Oh, oh yeah. We'll

EAU: get into all of it. Oh yeah. Okay. So what is sleep if we define it?

EW: Sure.

EAU: A simplified definition is like a reduced state of voluntary motor activity. Yep. So you're not [00:10:00] moving, uh, you've got a decreased response to stimulation. Mm-hmm. And in general, there's a stereotypic posture associated with sleep. I know you'll talk more about that, Erin, but in humans, no. I just

EW: love the thought of the stereotypic posture.

EAU: I know, right? It's

EW: very cute.

EAU: In humans, we lay down, right? Yeah. That's what we do for sleep. And in contrast to other states that might be similar to sleep, like say a coma.

EW: Mm-hmm.

EAU: Sleep is easily reversible.

EW: Mm-hmm.

EAU: Okay. But in reality, in medicine, we have defined sleep based on specific patterns of electrical activity in our brains.

EW: E EEGs,

EAU: EEGs. So let's get into it. We talked about EEGs or electroencephalograms in our epilepsy episode.

EW: Oh gosh, that was a long time ago.

EAU: It was a while back. And at that time I was just like, I don't wanna get into it. Goodbye. And we just didn't talk about it. It,

EW: we'll do it someday. Today is that day.

EAU: Today's the day. So EEGs measure the electrical activity happening in our brains.

EW: Mm-hmm.

EAU: And the readouts of EEGs, when you see them on paper or on a computer, are these wave patterns. Yeah. Kind of like if you've ever edited like a sound. Uh, file. You see these little wave patterns, they look very similar to that. And waves, if anyone hasn't taken physics in a long time, are measured by two main, main measurements, and that is amplitude. Mm-hmm. Which is the height of the waves and frequency, which is the number of waves per second or per unit of time.

EW: Right.

EAU: Okay. So the higher the frequency, that means the faster the waves, the closer together the waves are. And we call that, uh. High frequency

EW: uhhuh,

EAU: and then lower frequency are slower waves.

EW: Okay.

EAU: So longer wavelength. Longer frequency. Okay. Depending on what our brain is doing, our EEG makes a number of kind of predictable patterns, some of which we only see when we're awake, and some of which we only really see when we're asleep. So when we're awake, our EEG pattern shows these fast frequency, low amplitude waves,

EW: fast frequency, low amplitude,

EAU: high frequency, low amplitude. Yeah, yeah, yeah, yeah. So they're like close together waves. Yeah. And they're, they're not,

EW: right.

EAU: They're just little, little baby waves.

EW: Yeah.

EAU: And the most common two types of waveforms are called alpha waves. And beta waves. There's a few others too.

EW: Uhhuh,

EAU: um, alpha rhythms are like calm, eyes closed, like meditation type of vibes. Mm-hmm. And then beta waves are what we see more with like. Activity of the brain.

EW: Sorry. So we're talking about, these are sleep

EAU: awake?

EW: Sleep. Oh, these are

EAU: awake.

EW: These are awake. Okay. Okay.

EAU: This is what we're doing right now.

EW: Yeah, yeah, yeah.

EAU: We're probably beta waving

EW: to each other. We're beta. We're definitely beta waving,

EAU: not calm at all. Um, but during sleep, our EEG patterns change and we can measure more than just the brain electricity, actually. So when we're measuring sleep, there's three main sets of measurements that we're looking at. Mm-hmm. The EEG, which is your brain electrical activity, the EMG or electro myelogram, which records activity in our skeletal muscles.

EW: Okay.

EAU: And then the EOG or electrogram?

EW: Yes.

EAU: Which is measuring. Yeah.

EW: Rapid eye movement.

EAU: Yes. Horizontal eye movement. Um, and if we put all three of these together, they result in what's called a polysomnogram or PSG? Yes.

EW: Mm-hmm.

EAU: So you can look up a picture of A PSG, but it's like a lot of wires all over A lot

EW: of, yeah.

EAU: And sometimes there's more if you're measuring like your pulse ox and your heart rate and things like that too.

EW: Okay. I've always wondered this about sleep study uhhuh things.

EAU: Yeah.

EW: I feel like I would sleep terribly.

EAU: I know it's a, it's a valid concern. I don't have an answer for it.

EW: Okay. So like, how, okay, another question then. Uhhuh, how many nights will you sleep with wires, et cetera, to get like a good model of what your sleep is like?

EAU: That's a great question. I don't know a lot. A lot of times it, it might just be one night. Or just

EW: one

EAU: night. Yeah. But it totally depends on like what the scenario is, what the study is, and like what information they get from that kind of a thing.

EW: I find that so interesting because I feel like sleep is so variable.

EAU: Oh, it's so variable. Erin. It can totally be so variable.

EW: Yeah. Okay.

EAU: No, so I don't have a great answer to that.

EW: Okay.

EAU: Yeah, yeah. Totally. Totally depends on the study and what they're doing, what they're looking for. But based on these PSG readings, mm-hmm. What we've done over the years in studying many people for longer periods and in the lab, et cetera, we now can divide sleep into two main. Phases.

EW: Mm-hmm.

EAU: There's REM sleep.

EW: Just two. Okay.

EAU: Well, two main like divisions.

EW: Yeah.

EAU: Yeah. Yeah. There's phases within these, but the two main divisions are rem mm-hmm. Or rapid eye movement, sleep and non-REM or non rapid eye movement sleep.

EW: Yeah.

EAU: Within non-REM sleep, there are three different phases. Sometimes four, sometimes stage three and four are separated.

EW: And this is just depending on classification, not like,

EAU: yeah. The older, the older literature kind of says there's four stages of non rem um, and the newer literature is like realistically deep sleep is all deep sleep. We'll just call it phase three.

EW: Oh, interesting.

EAU: [00:15:00] Yeah. Okay. So anyways, doesn't really matter, but let's walk through what a night of sleep looks like together. Um, because we fall asleep in relatively predictable patterns and as we fall asleep mm-hmm. Our brainwaves kind of get slower and slower as we go. So, like I said before, as we're awake and relaxed, our brain is in this alpha wave pattern, which is low amplitude,

relatively high frequency waves. Then as we fall into stage one sleep, which is one of the stages of non-REM mm-hmm. We call it kind of drowsiness, we'll slip into this pattern called theta waves.

EW: Okay.

EAU: Which is slightly lower frequency, still low amplitude,

EW: slightly lower frequency,

EAU: so Okay. A little longer wavelengths and a little longer frequency

EW: mm-hmm.

EAU: Than, uh, the

EW: alpha,

EAU: alpha, alpha waves. Alpha, yeah. But still low amplitude,

EW: so these

EAU: little waves. Okay. So just

EW: chilling down there, okay? Mm-hmm.

EAU: Muscle wise, you might have these little like twitches or muscle jerks, as we all know.

EW: Why

EAU: I don't know. Okay.

EW: Okay.

EAU: And then stage two is when you start to truly fall asleep, this is when conscious awareness is gone. Your muscle activity decreases substantially, and your brainwaves will continue in this theta wave pattern. But then we see them punctuated by these really weird little bursts of activity, these short little bursts of super high frequency events that are called spindles, followed by what's

called a K complex, which is this very, uh, it's a low frequency, high amplitude, just like one two punch,

EW: low frequency, high amplitude.

EAU: So like wide Yeah. And tall.

EW: Weird.

EAU: There's one, and that's a K complex.

EW: Okay.

EAU: And that's like stage two. So we see this mostly like slightly chiller pattern than awake and then little bursts of

EW: Yeah, yeah.

EAU: Like a, almost like a

EW: heartbeat kind of.

EAU: Yeah. But sure. Why we'll say, sure.

EW: Yeah.

EAU: And then after stage two, we fall into deep sleep or slow wave sleep, stage three of non-REM

EW: slow wave. So I'm guessing frequency goes down.

EAU: Yes.

EW: Tell me about amplitude.

EAU: Amplitude goes up. So we see this high amplitude, low, low frequency, slow waves that we call delta waves.

EW: Um, what, what is, what does it mean to have high amplitude, you know?

EAU: Yeah. So the waves are created essentially by this like, activity of our neurotransmitters happening all at once.

EW: Okay.

EAU: And so really it's that the, the activity patterns in various parts of our brain have slowed down. Essentially is what we're seeing

EW: for the frequency.

EAU: Right.

EW: And what about the amplitude?

EAU: I don't know the answer about amplitude. Okay. Yeah, I really don't, this is why I am like not an EEG expert and maybe someone who is can let us know because I don't. Um, but that is deep sleep or slow wave sleep. So we'll stay in that sleep for a period of time, dunno how long depends on you. And then we pop up quickly to stage two. We pass through that pretty quickly and then we enter our first rem sleep of the night.

EW: So, uh, deep sleep is one that's stage, that's the first thing that we encounter.

EAU: No, we go, we go stage one, stage one, stage two, stage three, which is deep sleep.

EW: Oh, okay.

EAU: We'll stay there for a little while and then we'll go stage two rem. Got it. Okay. And in contrast to all these other sleep patterns where waves are getting longer and yeah. REM sleep. Your brain EEG pattern looks like you're awake.

EW: Right?

EAU: It is an awake beta wave. So not even like a calm alpha wave pattern. It's like a beta wave type of pattern. Yeah.

EW: Like we're recording an episode in our sleep. In our sleep.

EAU: And REM sleep is also characterized by like a more awake type of physiology. Our blood pressure is higher, our heart rate is higher, our respiratory rate is higher compared to non REM sleep.

EW: What about our temperature? Our body temp?

EAU: Oh, that's a good question. I think our body temperature goes up as well too.

EW: Okay.

EAU: Still probably not quite as high as it is 'cause in general our body temperature falls with sleep. Right. But it's gonna go up compared to deep sleep.

EW: Okay.

EAU: However. We have two weird things happening in REM sleep that we do not see when we're awake. And that is these rapid horizontal eye movements.

EW: Yep.

EAU: That happen. Um, and our skeletal muscle activity is essentially atonic. We really do not move.

EW: We don't, so we move even less than we do in our falling asleep twitchy.

EAU: Correct.

EW: Yeah.

EAU: You might still have occasional muscle twitches.

EW: Right.

EAU: Um, but in general, your skeletal muscles, so like arms and legs are not really moving.

EW: I know that this is all foundational so that someday we will talk about sleep disorders in more detail. Yes. But it is making me want to ask 1001 questions.

EAU: Yeah.

EW: I mean about like what happens when [00:20:00] sleepwalking anyway, we Yeah,

EAU: yeah. Sleepwalking is something you'd see more in the deep sleep.

EW: In the deep sleep, okay.

EAU: Because you're, again, in REM sleep, your muscles are not moving.

EW: You're right.

EAU: So in REM sleep we can see things like sleep paralysis. We think that that's like in rem rem sleep.

EW: Yeah. 'cause you can't move,

EAU: you're having basically rem sleep, uh, muscle activity, but with an awake brain where you actually do wake up. And that's what we think is happening in sleep paralysis. And that's all I'm gonna talk about when it comes to dreams. Yeah. FYI.

SRM: Yeah.

EAU: Um, so. In a night of sleep, we cycle through both non REM and REM sleep in a pretty typical pattern. We go from stage one to two to three, that quick pick stop at two and then back up to rem.

EW: Mm-hmm.

EAU: And that once we end that REM cycle is considered one sleep cycle. And in adults a sleep cycle lasts between like 90 and a hundred or so minutes.

EW: Okay.

EAU: So depending on how long you sleep at night, we might go through like four or five or more of these cycles.

EW: Okay. I have a question about,

EAU: give it to me.

EW: Um, the. Rem like deep sleep. So I remember reading that deep sleep happens early on in the night,

EAU: correct? Yes.

EW: Um, why, and but REM sleep happens throughout,

EAU: we tend to have more deep sleep early in the night.

EW: Mm-hmm.

EAU: And then like shorter periods of REM sleep earlier in the night and longer periods of REM sleep later in the night. And then it's possible that you might not like later in the night drop all the way down to that deep sleep like stage three n rem. You might maybe just go to stage two then up to REM a couple of times in your later sleep cycles.

EW: Hmm.

EAU: Yes, that is true. Why? I don't know. Erin, it's also really interesting because like the amount of deep sleep that you get also correlates to how much sleep you got, say, the night before. So if you are sleep deprived and you're running off of like sleep debt as they sometimes call it, um, then your next night of sleep will likely have more of that slow wave or deep sleep compared to the night before

EW: recovery sleep, kind of. Yeah. Yeah. So the, in terms of the breakdown of like I'm the sleep cycle. Not even like the number, but just the, the proportion overall. Ugh, I, I'm getting ahead of things. You

EAU: are. Yeah. But

EW: keep, you can ask it. I'm like, what, what proportion of sleep, quote unquote should be rem, should be deep sleep, should be whatever, right? Stage two.

EAU: Yeah. It depends on your age and your stage of life and things like that. So babies have like a lot more REM sleep than adults? Yeah, they've got like over 40% REM sleep adults. It's usually 20 to 30% is considered typical. Okay.

Um, and then 20, I think it's like 15 to 20%. It's in my notes from next episode. Okay. Okay. So we'll get more into it, but yeah, it's usually like 15 to 20% or so is deep sleep.

EW: Oh, wow.

EAU: Or should be deep sleep. Typical deep

EW: sleep. Oh my gosh. I mean, yeah.

EAU: And then the rest, is that like stage two type of sleep?

EW: Yeah.

EAU: Or bouncing between, you know, stage one and stage two,

EW: sort of like the, which is not, I mean, I feel like deep sleep and REM are like the stars of the show.

EAU: Yeah. They get, they get the cred, they get more, even though they're not the majority of your sleep. Right. Yeah.

EW: Which is also important.

EAU: It is. It is.

EW: Yeah.

EAU: But that is like how your sleep cycle goes throughout the night. Um, and it is gonna depend how much time you spend in each one of these from night to night, from person to person. And anybody who has one of those rings or one of those watches that's monitoring your sleep knows that these things are going to vary night to night.

EW: Yeah.

EAU: So, speaking of which, I just wanted to

EW: Good. Yeah. I'm glad you're talking about

EAU: this. Just wanted to talk about these real quick. Mm-hmm. Because there is so much out there right now that's like, you need one of these rings to monitor your sleep and you need to be monitoring your sleep. And these are, this one is the best one to be monitoring it, et cetera. Um, I found a paper. That was not sponsored by the manufacturer of any of these devices.

EW: Uhhuh?

EAU: Just the one.

EW: Just one.

EAU: There's a lot of other papers that are sponsored by that were like funded by the manufacturing of these things who will say like, oh, these are like 75 to 80% accurate compared to PSGs. Like, these are super, super accurate.

EW: Yeah.

EAU: So I found one paper that was comparing a number of different rings. It wasn't as much looking at the watches, um, that was trying to figure out could these be as good as PSGs that we do in clinic? Which is really important because especially to diagnose a lot of sleep disorders, like you do need this data

EW: and it's like accessibility. Exactly. And all of these things. Yeah. Yeah.

EAU: So if like, if we could use these clinically, that would be really awesome.

EW: Right. And then you're not having to wear all of these tubes that make you sleep poorly. Right. And then you're like, you're a terrible sleeper. You need all these things. And it's like, I was just had hooked up, couldn't sleep up to wires all night, I

EAU: just couldn't sleep Well and like the uh, ability to be able to do it at home

EW: Yeah.

EAU: Is so, yeah. So there's so much. That would be great if these things were really great. The problem is that. They're not, and it's not that they're not. Decent.

EW: Yeah.

EAU: But I, I will quote here [00:25:00] because I think that this quote kind of, um, summarizes it all. What they said was that even the ones that correlate very strongly with the PSGs mm-hmm. Who like on average agree with what the PSG readings are. They said that quote, this agreement masks substantial individual level inaccuracies prohibiting their use in clinical sleep medicine as accurate assessment of individual nights, including both nights with exceptionally low or high quality and quantity is essential for patient care.

EW: Mm-hmm.

EAU: So like on average, if you're just looking like population wide, sure they decently, they do decently well. But on a night to night basis, there's a lot of variability in how well it's capturing you as an individual.

EW: That makes sense.

EAU: So,

EW: so you can't wake up in the morning and go, how was last night?

EAU: Right?

EW: Oh yeah. Check. I see what happened. Yeah. Yeah, yeah, yeah. Like we did this morning, like

EAU: we did, like we've been doing the last couple of weeks.

EW: Mm-hmm. Mm-hmm. So,

EAU: yeah, so I, that's just what I wanna say about those. It's like they're not,

EW: I have heard that like so did, they're not great at distinguishing between, among the stages of sleep.

EAU: Correct. Yeah.

EW: But they are okay at distinguishing awake and sleep.

EAU: Yes. So like to get like total duration, they're pretty decent.

EW: Right.

EAU: But again, if you're trying to like, understand, especially like quality, what we call quality and like differentiating between the different stages and things like that. Um, or even if you're trying to, and this paper was specifically more looking at people who have say like obstructive sleep apnea or some other kind of sleep disorder where you really wanna be able to get that fine detail. Yeah. Um, they weren't gonna be. Effective for that. I see. And most of the studies funded by the manufacturers are looking at like the general population, so like healthy people without any diagnosed sleep disorders or anything. So it's also a different population level We're looking at

EW: different. Right, right.

EAU: So yeah, so that, that's what we know about those devices. Moving on, before I get too deep into like why, what, what is happening? We know now what our brains are doing. As we monitor them. Uh, but before we get into the maybe why of it, I wanna touch base really quickly on kind of how we sleep. Like what is driving our sleep.

EW: Okay. Okay.

EAU: Sleep

EW: drive.

EAU: Sleep drive. That's the answer. We did talk a little bit about this in our circadian rhythm episode.

EW: Yes.

EAU: Because our circadian rhythm is one of the drivers of our sleep. So as a recap, so that you don't have to listen to that episode again, uh, there's a collection of cells deep in like the center front of our brain, behind our eyes.

EW: Mm-hmm.

EAU: Deep in our brain. That's called the matic nucleus. That is the clock of our brain.

EW: The SCN.

EAU: The SCN.

EW: Yep.

EAU: And it basically generates this close to 24 hour rhythm. All of our cells do this to one degree or another,

EW: which is really cool.

EAU: It's so cool. But this is like the master clock that keeps all of our body functions in sync, mostly using signals from light and dark from the sun. Right. Yeah. And this circadian clock of ours drives things like hormone production among many other things that help to promote sleep and awake at the right times of day and night. Mm-hmm. For us as diurnal creatures. But our brain also has other mechanisms, aside from just the circadian clock, that help to promote both sleep and wakefulness. Or what's called arousal in the literature.

EW: Yeah. Yeah.

EAU: And it's mostly parts of our brain stem,

EW: right.

EAU: And our brain stem is like the deep. Back part of our brain that connects to our spinal cord,

EW: the stem,

EAU: the stem, um, and parts of our brain stem release a whole bunch of neurotransmitters that are involved mostly in promoting wakefulness.

EW: In wakefulness.

EAU: Right. So promoting us being awake. Yeah. And active during the day. Okay. These are things like histamine, dopamine, noradrenaline, serotonin, all of these mm-hmm. Types of things that act in other parts of our brain to be like, go do things, be awake.

EW: Yeah.

EAU: That's what I imagine they're saying. And we think that sleep ends up happening from a couple things, uh, changing in our brain. One is that there's other parts of our brain closer towards the front of it that send signals to start to inhibit. Those awake signals. So like at some point in the day mm-hmm. Other parts of our brain will send signals and be like, Hey listen, histamine chill out a little bit. You've done enough today. So they'll start to inhibit the release of histamine or orexin or other signals that are saying, be awake, be awake. Right.

EW: And so, okay.

EAU: And then the other part,

EW: I'll wait.

EAU: Yeah. The other part is that, and this I think is really interesting. We also. During the day, like just with our normal metabolism, how our brain is functioning all day long. We are making a bunch of stuff. And some of those things we think act as like sleepy substances, where as they build up in our brains throughout the day as the concentration of this substance, the, or these substances really accumulate [00:30:00] in our body tissues, including our brain. They increase sleep pressure. Yeah. One of the classic ones of these is adenosine.

EW: Mm-hmm.

EAU: And adenosine, we produce just as a byproduct of metabolism, but as we produce that and it builds up in our brain, it makes us more sleepy. Caffeine.

EW: Yep.

EAU: Which we talked about.

EW: I was just about to ask about caffeine.

EAU: Yeah. Caffeine inhibits the adenosine receptors, so it tricks our brain into thinking that we don't have a buildup of this sleepy substance.

EW: Right.

EAU: When we actually do. And that's how it works to keep us awake.

EW: What about like mourning though? Because if we're start, are we starting the day fresh? Everything's cleared out.

EAU: Mm-hmm.

EW: Tell me again about caffeine. It's been way too long since that episode.

EAU: Yeah. So caffeine basically like we, because we're making adenosine, just like from metabolism, we break down a TP, we make adenosine. Yep. So throughout the day it's just gonna build up, build up, build up, build up. Yeah. And it's gonna bind to these receptors that do inhibition. Stuff that's like go to sleep. Go to sleep. Caffeine binds to those receptors. Right? So it doesn't matter how much adenosine you have, there's nothing for them to bind to. Got it. Because caffeine is blocking them. And so it tricks our brain into being like, there's no adenosine here. I don't need to go to sleep. And it is quite effective. Like there's so many studies on like caffeine helping to alleviate sleepiness.

EW: I, I think that like what is so interesting? Okay. Speaking for myself.

EAU: Yeah.

EW: I feel like when, if I am sleepy mm-hmm. During the day, uh, or in the evening or whatever, just at, at any point in the day, I'm like, I didn't get good sleep. I'm really tired. And I feel like I, I expect that if to get really good sleep or getting really good sleep makes me have no sleep drive. And that's the ideal.

EAU: Oh, that's so interesting.

EW: You know what I mean? Yeah, yeah. I'm

EAU: like, where, like, you shouldn't ever be sleepy

EW: if you're getting good sleep. I shouldn't be sleepy until it's right before bed. And now I just lay it back, close my eyes and I'm out and

EAU: boom.

EW: And I'm like, that would be great.

EAU: That would be great.

EW: But like,

EAU: it's not realistic.

EW: It's not realistic. So sleep drive is so important, is what I'm saying.

EAU: It's, well, and it's also, it's interesting too because there is this, um. There's like a, a buildup of our sleep drive versus our circadian rhythm. And so sometimes those kind of cross paths at a weird time where we can get more sleepy than we expect in like the middle afternoon or something like that.

EW: Yeah.

EAU: Um, and, and so that's part of why we might feel sleepy at times of day, where we think like, I don't understand why I feel sleepy right now.

EW: Right.

EAU: Um, and it's just maybe because things are, you know, it hasn't overlapped in exactly the right way today. Mm-hmm. Kind of a thing. Mm-hmm. But it doesn't necessarily mean that your sleep was terrible the night before. Right. So it is really interesting, and this, I'm probably not doing it justice, but there's obviously a lot, and it's not just adenosine, right? There's a lot of other substances that we think are involved in this. So there's a lot that goes into when and how we're sleepy. And some of it too is genetics. So we know that some of our sleep drive and a lot of our circadian rhythm, like whether we are a night owl or a morning. Bird.

EW: Morning Lark.

EAU: Morning Lark. Like some of that is genetics. Mm-hmm. There's also some genetic, um, markers that we think are associated with like very short sleep, where people sleep very little but are totally fine.

EW: Oh yeah.

EAU: Right. Um, and our need for and are pattern of sleep also changes drastically over our lifetime.

EW: It does.

EAU: My favorite example of this are tiny babies.

EW: Oh yeah.

EAU: Because. Even though fetus is sleep when they are still in utero, um, they do that like mostly in sync with the human who's housing them. Uh, but once a baby is born mm-hmm. They do not have a well-defined circadian clock.

EW: It's a mess.

EAU: It is a disaster.

EW: Yeah.

EAU: Um, their circadian clock is much less than 24 hours.

EW: Mm-hmm.

EAU: And their, um, sleep pattern, like I said, a sleep cycle is like 90 minutes. It's much shorter in babies. So they're also cycling through a whole cycle of sleep in much less time.

EW: Yep.

EAU: Um, and their sleep pattern is totally random.

EW: Yeah.

EAU: Completely random. Yeah. And they'll sleep up to like all over the place 16 hours a day

EW: like a dog

EAU: and not in any pattern that's compatible with adult sleep patterns.

EW: Mm-hmm.

EAU: And it's not until the first, like six to 12 months of life that they start to consolidate their sleep into these 24 hour patterns. Mm-hmm. And because I fell into what is very common these days of. Being very obsessive about my infant sleep when my first child was born. Mm-hmm. I have data, um, that you can

check out if you're watching the YouTube of my kid's sleep pattern when he was an infant. And you can see that it is literally all over the place.

EW: I don't think anyone listening is surprised that you collected data. I know for how many months of your first kid's life?

EAU: Oh, so many months.

EW: So many.

EAU: I mean, the first probably 15

EW: months. And that's just one aspect of it.

EAU: I had

EW: all

EAU: the

data

EW: amount of proof. I remember too. Yeah.

EAU: There was so much. Yeah. Yeah. The second one, I didn't do any of that. Um, but you can then see that by 11 or 12 months. Even though sleep wasn't great, you can see this 24 hour pattern emerge where there's like a [00:35:00] nap in the middle of the day, or maybe two naps, but then the majority of sleep is happening over the nighttime period. Yeah. And that is because that's how long it really takes for infants to develop this 24 hour pattern, which I think is just so interesting. And then the amount of sleep that we need over our lifetime changes too. Kids need a lot more sleep. Teenagers we talked about in our circadian rhythm episode, do actually have a shift in their circadian rhythm towards night owl tendencies.

EW: Yeah.

EAU: And so they tend to sleep later and wake up later, and that can put them out of sync with our modern society.

EW: Mm-hmm.

EAU: And then as adults, especially older adults, a lot of times we don't need quite as much sleep, so the amount of sleep that we actually need varies. So why do we need this much sleep? Like. Why I'm, are you asking me? I'm asking you, but I'm not, it's a, it's a rhetorical question that I'm gonna try and answer.

EW: We're asking the room,

EAU: we're asking, does anybody know?

EW: Does anyone know?

EAU: Um, we still like, we still don't really know.

EW: We don't

EAU: exactly what our brains are doing in terms of the function of our sleep.

EW: Like we know what happens. We know there are bad things that happen when we don't get enough sleep.

EAU: Correct.

EW: I'm what

EAU: Talk a lot about That's

EW: what, that's what guides a lot of our assumptions about why sleep is important.

EAU: Yes. And like what our brains are really like doing during sleep.

EW: Yeah.

EAU: So we do see, and one of the, one of the hypotheses, I'll kind of walk through the biggest ones. One of the hypotheses is that it is kind of energy conservation. During sleep. Yeah. And that is because we do see a relative decrease in metabolism during sleep.

EW: Mm-hmm.

EAU: However,

EW: not really. I mean, especially Yeah. Yeah. Yeah.

EAU: Especially if you're looking at total body metabolism. Like during REM sleep, our metabolism is essentially the same as when we're awake. Um, our brain metabolism does decrease substantially, especially during non REM sleep.

EW: Mm-hmm.

EAU: But again, that's only a portion of our total sleep.

EW: Right.

EAU: Um, and it's nothing like, like our sleep is nothing like hibernation or torpor or something where we're truly decreasing metabolism. Yeah. So that's clearly not the whole story could be part of it. There is a lot of evidence that we see changes in things like gene expression, so like mm-hmm. Certain things turn on and certain things turn off when we're asleep. That only happens when we're asleep, so we think that must be important. Why exactly? We don't know.

EW: I mean, yeah,

EAU: because I talked about these like sleepy substances and things like that. We do think that there's sort of like a clean out of the buildup of these neurotransmitters that happens during the day.

EW: Detox.

EAU: Yeah. Brain detox. I hate that word. It's not accurate, but, but we do see like an increase of cerebral spinal fluid flow. Yeah. During sleep and things like

EW: washes over the brain is over. I've just heard it described. Yeah.

EAU: Getting rid of all these neurotransmitters and replenishing others as well. It's

EW: very like, it's a very satisfying image. It's to think about It's, yeah. Just like who, just like a gentle washing of the brain.

EAU: That's what you're hearing. Mm-hmm. As you fall asleep.

EW: Mm-hmm.

EAU: Anyways,

EW: great. White noise.

EAU: How much of, is that the function of sleep, maybe?

EW: Yeah.

EAU: And then one of the biggest hypotheses is that sleep is required for consolidation of our memory, memory consolidation. Why do we have to whisper it?

EW: I don't know.

EAU: And we do know there's something called sleep dependent memory processing. Yeah. Where there's done a, we've done a bunch of studies where if you give humans or animals a task and then deprive them of sleep, they never really learn that task to, to the same degree that they would if you let them sleep after it.

EW: Mm-hmm. Mm-hmm.

EAU: But even this, the data is a little, it's a little bit controversial still.

EW: Hmm.

EAU: That like, is this truly the function of sleep? Especially because it's like we're trying to compare human brains to like, well, we don't ha like lots of animals sleep that don't. We don't know anything about their memory. Oh, you'll get to it, you'll get to it with those eyebrows. Sorry. I love it. But, but yeah, that's, that is one of the kind of big hypotheses that, like sleep really is essential for our memory.

EW: I, I what? Okay. But like, I don't understand why that's controversial. Uh, only in that if it's overstated that this is the

EAU: function. That's what it is.

EW: Okay.

EAU: That's what it is. It's that it, like we know that it's essential. It is a function. It is a function. Yeah. But I think, I think that it's just that people are so obsessed with this idea that there is like a reason for things.

EW: Nah, that's just, sorry,

EAU: but that's true, right? Like it's not mean. Sure. We're not gonna get to Oh oh. Like

EW: right

EAU: this like,

EW: uh, enlightened, glorious will not,

EAU: right.

EW: Will not arrive.

EAU: It's pro. A bunch of different things happen when we sleep.

EW: I know. It, it's not

EAU: all them

EW: are important. It's not as satisfying as

EAU: Right.

EW: We found it here. Is the answer,

EAU: the reason for sleep.

EW: Right? The singular

EAU: function of

EW: sleep. The single bullet point. Yeah.

EAU: That's ridiculous. We sleep for a bunch of different reasons. Okay. And as we'll see in next episode, if we don't, there's a problem. A

EW: lot of different things happen. A

EAU: bunch of problems

EW: beyond memory.

EAU: But [00:40:00] that's for next episode. So Erin, what I'd like to know from you, please, is like. Obviously I know my dog sleeps my cat. All he does is sleep.

EW: Yeah.

EAU: Do do all animals sleep, like,

EW: oh, do me.

EAU: Do

EW: they do they do

EAU: they,

EW: I'll tell you.

EAU: Okay.

EW: In 1971, renowned sleep researcher Alan Reen wrote that quote, if sleep does not serve an absolute vital function, then it is the biggest mistake the evolutionary process has ever made. End quote.

EAU: I love that.

EW: Right?

EAU: Yeah.

EW: Okay, so let's, let's break that statement down first. Why would sleep be a mistake? It leaves us vulnerable super to predators and bugs and parasites transmitted by bugs. Mm-hmm. And it takes up precious time that we could be using to do something else, right? Like forage or mate, or socialize, or read a

book or do your taxes or play with your kids or exercise or cook a nice meal or work more hours at the office.

EAU: So true.

EW: So many things. I know that many tech bros view sleep as a mistake.

EAU: Oh yeah. You don't even need it.

EW: You don't need it.

EAU: You could just wake up at 3:00 AM Sorry.

EW: Wow. I think something just happened there.

EAU: Something I, I flipped.

EW: I liked it. Mm-hmm. Um, but I mean, that aside though, I do think that most of us have, at one point in our lives, wished that we didn't have to sleep as much as we did because like we could get so much more done. I know that I have wished that like, gosh, I could just, if I didn't have to sleep, sleep as much, I could do things I wanted to do. It is undeniable that sleep is costly.

EAU: Mm-hmm.

EW: But it would only be a mistake if we didn't get anything out of it.

EAU: Right.

EW: Okay. So second. Does sleep serve a vital function from what you just told us, Erin, it serves multiple vital multiples, vital functions, multiples. We may not know precisely how sleep helps us and the pathways that it works along, but we know from experimental and observational research that sleep deprivation is harmful. Mm-hmm. And that when we lose out on sleep, our body compensates by increasing sleep. There's like sleep homeostasis kind of. Yes.

EAU: Totally.

EW: Okay. So now why would sleep be the biggest, uh, mistake that the evolutionary process ever made? Because sleep is ubiquitous across the animal kingdom.

EAU: Love this.

EW: At this point in our understanding of sleep. It would be much harder to prove that an animal doesn't sleep than determine that it does.

EAU: Okay.

EW: Even cave fish species, like the Mexican blind cave fish, which has lost eyes and pigmentation and much of their circadian rhythm patterns

EAU: because they're in the complete black

EW: darkness. Complete darkness. Yeah. They still retain some sleep.

EAU: Wow.

EW: Interesting. It's reduced as much as like 80%, but still there are indications of sleep. What does indications of sleep mean?

EAU: Especially in a

EW: fish? I know. Okay, so for us to recognize and measure sleep in non-human animals, we have to step outside of our human box, right? So. For one, there's a logistical challenge of recording an EEG on a Mexican blind K fish. Like that's, can you do it? Can you do it? I don't know. It's pretty difficult, challenging. Sure. And then for two, we wanna be able to observe sleep in more natural settings. Mm-hmm. And for three, it's important to step back from our tendency to make humans like the ideal the norm, right? Like, oh, if you don't sleep like a human, are you sleeping? You even sleeping at

EAU: all.

EW: So we can measure sleep electro electrophysiological using EEGs. Okay. And we have done that for a number of animal species. Okay. And we can measure it behaviorally.

EAU: Mm-hmm.

EW: So researchers use five criteria to say that an animal sleeps number one, and it's very similar, like you mentioned some of these. Yeah. Number one, prolonged behavioral quiescence. Basically stop doing stuff,

EAU: right? You're not, you're not doing stuff. You're

EW: not doing it. Okay. Number two, um, reversible upon stimulation, unlike, like you said, torpor or a coma. Okay? Three. A species specific posture. It's not just ye, it's not just laying down, laying down or tucking your antenna away. Um, and then I have a picture of my dog in bagel formation, which, which is a very bagel, he's one of his favorites. Uhhuh number four, increased arousal threshold. So you need a louder or like more, uh, substantial stimulus, right? Like a noise to get you to respond. That if you're awake,

EAU: decreased response to stimulation. Same

EW: idea. You maybe be like whispering, like, Hey, wake up now, could

EAU: you please roll over?

EW: Right.

EAU: Might not do it.

EW: You're snoring. So like your senses are dulled,

EAU: right?

EW: And number five, rebound after being sleep deprived, you sleep more. And so these are the things that we can use to say that animal is sleeping because it's doing all these things. Okay? And so using these criteria we can describe and define sleep in a huge array of species. [00:45:00] Like pond snails, octopus cuttlefish, which may even exhibit REM sleep.

EAU: Sorry, snails.

EW: Snails. Oh, it gets even more extreme. Yeah. Lobsters, mice, armadillos flies. And funnily enough, whether animals truly sleep is kind of a more recent question. Ancient scholars like Aristotle fully believed that animals sleep. Like of course, of course they sleep. And there's an adorable quote I'm gonna read to you from a an 1865 book called Yearbook of Facts. Quote, "an insect composes itself to sleep with its antenna folded. Some of the Beatles adjust them to their breast. The butterfly seeks some particular aspect of a tree and folds vertically its wings, throws back the antennae, and remains motionless and insensible to all external circumstances. When caterpillars, which are insatiable feeders are observed, resting, immovable with their heads down, they are asleep. "

EAU: I love it.

EW: Quote. Isn't that cute? They're

EAU: like, we don't need an E, EG, bro.

EW: Just look at the bugs. No, look at their little antennae. They're all

EAU: beep boop.

EW: Yeah,

EAU: and you can hear them quietly. Souring.

EW: Oh yeah. So sweet. So

EAU: cute.

EW: But it's still helpful to have these specific standards for what counts as sleep, because we can then also try to trace the genetic basis Oh. And neurological pathways of sleep.

EAU: Okay.

EW: Okay. So for example, sea Elegance, the research world's favorite worm mm-hmm. Contains a mere 302 neurons

EAU: Wow.

EW: Compared to an adult fruit fly, which has 250,000. Wow. Okay. So, right. And since C elegant sleeps, we can map out the neural pathway of sleep, at least in that critter, because there are so few neurons. So

EAU: few. Wow, that's really cool. Yeah.

EW: Okay. Really cool. But what's even more amazing is that this isn't the quote unquote like simplest creature to sleep.

EAU: Okay.

EW: Using those behavioral criteria, researchers concluded that the upside down jellyfish in the genus Cassiopeia sleep.

EAU: Jellyfish jellyfish. Jellyfish.

EW: Unlike sea elegance, these jellyfish, they don't have a central nervous system. No, just a nerve net. Yeah. Like rings of neurons. Yeah. And so scientists observed that when the jellyfish is active, their nerve net contracts and causes pulsing behavior that lets them feed and get nutrients. But at night the pulsing behavior reduces and they become less responsive to external stimuli. And then when you disrupt their resting time, like you keep splashing 'em with water or waves or whatever, they, um, will pulse even less the next day. Indicative of sleep. Rebound.

EAU: Oh my gosh.

EW: Right.

EAU: I love it.

EW: Isn't that wild? Yes. And so this means that sleep likely evolved before a central nervous system.

EAU: That is so interesting.

EW: Huge. Huge.

EAU: Especially the context of memory and stuff like that.

EW: Right. Well, I mean. Okay. Yeah.

EAU: Okay.

EW: Yeah, yeah, yeah, yeah. But like, this is, this is an ancient and widespread thing. Right. And so given how ancient and widespread it is, it doesn't really seem like, uh, sleep is, it's, is a mistake.

EAU: No.

EW: And as far as, I mean, sleep doesn't get fossilized because it's a behavior. But as far as we can tell, no species has entirely lost the capacity for sleep.

Okay. Meaning that it is still so vital to, you can't get around it. Existence. Yeah. Yeah. Sleep disturbances or a lack of sleep can have profound effects on health and overall performance. Vulnerability to infections, attentiveness, reaction time, memory formation, mollusks that have been deprived of sleep cannot form new memories. So like it goes to,

EAU: how do you measure a mollusks memory?

EW: I don't know. I didn't go that deep.

EAU: I Now I need to,

EW: oh, I will find the paper for you and send it if your way. I love it. Uh, and then there are a few gruesome experiments where rats that were completely deprived of sleep for like a long period of time died.

EAU: Oh my gosh.

EW: They died. Yeah. The world record for, uh, no sleep, sleep deprivation and a human is 11 days. I heard that. 264 hours held by a San Diego teenager named Randy Gardner, who in 1965 played basketball throughout the night to stay awake. But apparently, like I think in, uh, I don't know how they determine this, but he, they were discovering that he was taking like micro naps. Micro

EAU: naps. Of course he was.

EW: And so was it truly 264 hours? No. You know? Yeah.

EAU: I mean, his brain was falling asleep. He just did not know it.

EW: He didn't know it. Yeah. And no one else knew, right. That he was Yeah. But in any case, that's like a, do not try that at home, no situation.

EAU: Mm-hmm.

EW: Yeah. So even though we all sleep in some capacity, we don't all sleep the same.

EAU: Mm-hmm.

EW: Elephants sleep about half the time that humans do. Four hours compared to our eight. Okay. Which is really more like six to seven brown baths. Sleep about 19 hours a day. It's similar to armadillos, koalas, sleep even longer, 20 to 22 hours. Meanwhile, donkeys sleep about three hours. Cats sleep 12 and a half hours a day. Which seems like an underestimate,

EAU: absolutely an underestimate.

EW: Goats 5.3 on average Guinea pigs, 9.4. I mean, just to show you, it's all over the map. Yeah. And really many of these sleep duration estimates we do have to take with a grain of [00:50:00] salt because like we are measuring sleep in the lab. Right. And so there tends to be a, um, a bias towards like, longer sleep because they're like, I don't have to worry about am predators. What else I gonna

EAU: do? Yeah,

EW: I've got food here. Yeah, I've got water. I'm chilling.

EAU: Might as well take a nap.

EW: Might as well just nap all the time. But even still, we do have this huge variation in how much sleep different species need, but duration is just one component of sleep. Mm-hmm. As we talked about, there's also whether you sleep in one big chunk Mm. Or multiple times throughout the day or throughout the night, like monophasic sleep is one big chunk, uh, which is what humans usually do. Big asterisk on that biphasic sleep, which is two chunks, which is what humans maybe used to do. Asterisk on that. Or polyphasic sleep, like multiple chunks. Like my dog throughout, like sleeps constantly the

EAU: cat.

EW: Yeah. Whether you tend to sleep during the nighttime, during, or during the day is another, uh, big component of this. Like a red-tailed hawk versus a barn owl. Mm-hmm. For instance. Mm-hmm. If we're talking birds and not all owls are nocturnal, A lot are corpuscular. So it took me a while to find one that I was like, is a bar such a

EAU: great word

EW: prop. I love props. Yeah. It's very good. Mm-hmm. There's also whether or not you have REM sleep. So generally speaking, mammals and birds are the only animals with REM sleep except for maybe the cuttlefish.

EAU: That's so weird.

EW: I know. I know. And not all mammals have REM sleep.

EAU: Really?

EW: Yeah.

EAU: Okay.

EW: Um, so side note, REM sleep evolved after non-REM sleep. Okay. As far as we can tell. And it's thought to have emerged in mammals and birds independently.

EAU: Ooh, that's interesting.

EW: Yeah. So, which indicates that it might be really important for cognitive activities or warm bloodedness like endo, AKA endothermic.

EAU: Oh, interesting. Okay.

EW: Cuttlefish. I don't know.

EAU: Coness. Cuttlefish are weird ones.

EW: They are.

EAU: I love them. They're so cute.

EW: Um, but if you do have REM sleep, you know, how long are your sleep cycles between REM and non-REM? So for instance, you said human is 90 minutes or so? Mm-hmm. The chinchilla is six minutes.

EAU: Six minutes. They go through a whole sleep cycle in six minutes.

EW: Yeah.

EAU: Oh my gosh. They're

EW: like done.

EAU: And up.

EW: There's also whether you sleep with all of your brain or half of it,

EAU: that's, I think one of my favorite facts I learned in a children's book accidentally before we were, it was called Sleepy. Oh yes. And that is where I learned about uni hemispheric sleep,

EW: uni hemispheric sleep. Yep. It's a real thing. Sleeping with one eye open. It is a real thing. Aquatic mammals like whales, dolphins, and seals, as well as some bird species. Especially those that are undergoing like long migrations.

EAU: Oh, like the, um, what's the one that never touches the land for like

EW: albatross?

EAU: Yeah. Is that it?

EW: Is that it? Oh gosh, that's right. I, I don't know. Woo. Sorry. Sorry. Ornithologists. Um, but yeah, uni, he, uni hemispheric sleep. And uh, we've got a little, uh, thing here that shows like the EEG of what it looks like when you have like one part of the brain. So

EAU: it's like part of your brain is on and part of your brain is off.

EW: Yeah.

EAU: Oh my gosh, that's so interesting.

EW: It's amazing

EAU: in the right and the left.

EW: Oh wow. And what's even weirder about this is that whales, dolphins, and poses who do this uni hemispheric sleep uhhuh, they don't seem to have REM sleep. Or if they do, it's not in a form that we recognize.

EAU: Oh, that's so interesting.

EW: Yeah. So it's like, did they lose REM sleep

EAU: right when they went back to the oceans?

EW: Right. I don't know. I don't know. Okay. But why do aquatic mammals sleep with just one half of their brain? I mean, there's a few different possible reasons, right? Yeah. So one is because they need to breathe, right? And so they need to be able to come up and have that more active thing. Another is to reduce heat loss. Apparently it's supposed to help with like thermo generation.

EAU: Interesting.

EW: And a third is to be on the lookout for predators. And a fourth is to stay, to stay close to one another. Oh. 'cause you can really drift apart. 'cause the water. Yeah. If you're

EAU: just drifting.

EW: Yeah.

EAU: Yeah.

EW: Like have you seen those amazing videos of sperm whales, all sleeping vertical? Like a forest Yeah. Of sperm whales. Yeah. Uh, sea otters of course hold hands when they sleep, which is just, ugh. It's so cute. You know how, you know how it's, I feel about sea otters. Cute. Yep. Uh, and unlike terrestrial mammals, newborn dolphins and orca whales are on the move from the first moment. Right. And unlike human babies, which sleep like you said, so much Oh, so much so randomly all over the place. These, um, baby dolphins and orca whales are continuously active for like four weeks. Like, no sleep. They

EAU: don't sleep at all.

EW: No. Sleep along with mom. Yeah.

EAU: Fascinating.

EW: Yep. Yep. And it's only after those weeks that sleep gradually returns. And this might be because it's just a really vulnerable time. Right. For those babies

EAU: you can't afford it.

EW: Yeah.

EAU: Huh.

EW: And even when sleeping, these, uh, aquatic mammals are moving quite a bit. So dolphins make counterclockwise circles regardless of which half of the brain is sleeping.

EAU: Counterclockwise circles.

EW: Mm-hmm.

EAU: Why?

EW: Great question. I do not know. I do not know

EAU: counterclockwise circles, regardless of which part of their brain is sleeping.

EW: [00:55:00] Yeah.

EAU: That is so interesting.

EW: I

EAU: know. Do they sleep? Um, sorry, I'm gonna ask more details. Uhhuh, do they sleep, like, obviously it's one half at a time, but is it like consolidated, like at nighttime they're gonna like, okay, 40 minutes on this half and then 40 minutes on this half or whatever?

EW: That's a good question. I don't know. Okay. I don't know.

EAU: Okay. I'm, so, I'm

EW: curious. I can say there's a really great paper that I have, I'll shout out at the end. Excellent. Um, that has like a lot more information on this. And even like pictures of dolphins sleeping at the bottom of like enclosures Oh wow. And whales and stuff like that. Yeah, yeah, yeah. I love it. Uh, okay. Fur seals, listen to this description. It's very cute. When fur seals sleep in water, they usually

float on their sides holding one front and two hind flippers in the air. The front flipper in the water constantly paddles. Isn't that cute? And the rest are just like up in the air. Uh, one eye is open and the other is closed.

EAU: Wow.

EW: Mm-hmm. Fur seals also are one of these creatures that spend some time on land. Mm-hmm. And guess what their sleep is like on land.

EAU: Uh, like a dog,

EW: like any other terrestrial mammal.

EAU: But when they're in the water, they uni hemispheric.

EW: They uni hemispheric sleep.

EAU: What?

EW: And when they're on land, both eyes are closed and they cycle through REM and non-REM.

EAU: But when they're in the water, they don't.

EW: Nope.

EAU: Oh, that is so interesting.

EW: I know, I know.

EAU: Oh, wow.

EW: It makes me like, I never, I mean, I have like, thought about sleep mostly in like a very selfish, like, am I sleeping enough? Oh my gosh. My sleep kind of away. But this has made me more interested in rem sleep than like, I, I

EAU: ever.

EW: Yeah.

EAU: Yeah. Same.

EW: Yeah.

EAU: I did not know any of that.

EW: Yep. Me either.

EAU: How interesting.

EW: It's amazing.

EAU: Yeah.

EW: Okay. So the, but the fact that sleep comes in all shapes and sizes across the animal kingdom and is even variable, like you said, within an individual's life mm-hmm. It shows us that sleep is not random.

EAU: Mm-hmm.

EW: Right. How a species sleeps is the outcome of millennia of adaptations, nor is sleep rigid. Right. There may be times when, when we need to go with less sleep than we, you know, ideally like to have migration midterms, having a newborn migration, mid migration, or

EAU: midterms.

I love it.

EW: Socializing stress. You know, there's a lot of different reasons that might affect our sleep duration and we can do that. We can sleep with, we can have less sleep than we'd like for a limited, like a certain amount of time, and then our bodies know to recover from that sleep debt. Mm-hmm. So if the way that we sleep is not random. What determines how species sleep? Why is a chinchilla have a six minute, six minute that I can't answer that. I dunno about that. But it is a, it is a great question overall, right? Um, and we don't exactly know. And so there are some general patterns that I'll, I'll take you through, but to every pattern, there's an exception. Exceptions.

EAU: Exceptions. Yeah.

EW: So if we take all that we know about sleep in animals and we look for similarities after controlling for how related they are, a few strong drivers emerge.

EAU: Okay.

EW: Predation.

EAU: Mm.

EW: Metabolism immune function, gestation length, brain mass, and neuro anatomical regions like the amygdala.

EAU: So these are all the parts of things that are contributing to how long and how, uh, an animal is sleeping.

EW: Um, mostly I would say like how long and the polyphasic versus

EAU: Got it.

EW: Yeah. Got it. Yeah. Monophasic, et cetera.

EAU: Okay.

EW: And, uh, I don't like, there are some aspects of REM and non rem, but like that seems, I mean, it's just like, it's really difficult to draw any sort of Yeah. Uh, like parallels.

EAU: Well, and I feel like it's so interesting 'cause I, one of the books that I read, it was like, how, how you define sleep in animals, like with this behavioral thing then also affects how we think about and look at the why of sleep. Right? Right. If you define it in slightly different ways, then you might come to a different conclusion as to the function of sleep.

EW: It's a little bit of a guiding hypothesis kind of a thing. Yeah. Yeah. And you're like, well. If, if REM is really, the questions that you're asking are driving the Yeah. Right. How you're looking for data.

EAU: If you're only counting REM sleep as sleep, then your conclusions are gonna be totally different. Right. Versus

EW: if you, or if like, is more rem sleep better?

EAU: Right. Ugh.

EW: Yeah. It's, it's

EAU: so

EW: interesting. It's really interesting. Okay, so let's talk about some of these, some of these different factors. Okay. When you're sleeping, you are in a vulnerable state. Yeah. Your senses are dulled, so you can't hear that twig snap and you're laying there motionless. Yeah. Looking like a nice, tasty snack for that tiger that's, you know, just caught yourself creeping away and creeping away from the creeping towards you actually. Right. Creeping away would be great creep, but. So you might be a little better off if you had like a burrow or a tree hole to Nestle into. But if you just plop down in an exposed area, you're, you're playing a very risky, bad news. Bears very risky game. Yeah. Mm-hmm. And so to lower that risk, you might sleep less.

EAU: Okay.

EW: And that is what we tend to see.

EAU: Hmm.

EW: Prey species or species that sleep in more vulnerable locations, like, uh, on the ground as opposed to like in the tree, they tend to have shorter sleep durations.

EAU: Interesting.

EW: And in one experiment, rats that encountered a predator got less sleep afterwards. Both REM [01:00:00] and non rem, they

EAU: were like on

EW: edge. Yeah. You're just on edge. You gotta be like, you're in lighter sleep, I guess. Yeah. Some research, actually, some researchers actually suggest that light sleepers and people with insomnia might have those predator or biting insect vigilance mechanisms on overdrive.

EAU: Oh, that's

EW: interesting. So if you're like someone who has really hard time getting into like you're awake at the drop of a, like just a little rustle.

EAU: Yeah.

EW: You might be. Maybe. That's right. It's just evolution. It's adaptive. Yeah. Not anymore though. You won't

EAU: get eaten.

EW: It once was adaptive. Yeah. And so sleeping in larger groups, like larger social groups, that might help counteract some of the vulnerability to predators while you're sleeping. But then there's also the trade off of social disturbances and parasite transmission. 'cause you're just like all together, all in that group. Yeah.

EAU: Yeah.

EW: But so it's like sleep alone and be easier prey or sleep in a group and get less sleep. Mm. Not necessarily worse. Mm-hmm. But like, and maybe it's more efficient sleep, but it does seem like sometimes it's shorter sleep.

EAU: Okay. Interesting.

EW: Or you could sleep while you're predators also sleep.

EAU: Mm-hmm.

EW: Okay. And predators tend to get more sleep. Interesting. On average.

EAU: It's fine, bro.

EW: Right. Like I'm chilling. And, and metabolism might also play a role in that. Okay. When it comes to predators versus prey, because herbivores, which are more generally, uh, more often prey, they, uh, need to eat more frequently. Mm-hmm. Because they have faster metabolisms or like their food is less calorically dense, right? Yeah. And so they have to spend a good chunk of their time foraging. Okay. Especially if their food is, their preferred food is dispersed

across the landscape. Mm-hmm. Like, oh, I have to get fruit trees and I have to go far to find them. And so you're like. Your commute is long.

EAU: Okay. Got it.

EW: And you're like, I gotta get back to my, my little burrow.

EAU: Yes.

EW: Yeah. Uh, animals with faster metabolisms relative to body size, also sleep less and smaller animals tend to sleep throughout the day. They're polyphasic sleepers.

EAU: Interesting.

EW: Uh, immune function. So we all know that not getting enough sleep leaves us more vulnerable to infections. Mm-hmm. And some studies suggest that species with longer sleep durations have higher white blood cell counts and are less likely to be parasitized.

EAU: Interesting.

EW: I think this is a very generality correlation, causation, all of that. Yeah. And finally, oh, there's also gestation length. So longer gestations are associated with shorter sleep.

EAU: So that's why like elephants you said get only four hours.

EW: Yeah.

EAU: That's really weird though. Why? Maybe it's just a correlation.

EW: Yeah. Could be.

EAU: They're all down to metabolism. I

EW: know.

EAU: We don't,

EW: I mean, that's like a lot. And this is like a very much an, I don't know. Yeah,

EAU: yeah, yeah.

EW: Episode. Um.

EAU: How interesting though.

EW: And then finally, bigger brains. I I per like

EAU: Per body

EW: size? Per body size. Yeah. And proportion of body size equals a bigger chunk of time spent in REM sleep.

EAU: In REM sleep specifically?

EW: Mm-hmm.

EAU: Okay.

EW: Mm-hmm. But again, this is all messy. So there was a cool paper though I read that showed how vastly different sleep could be for two closely related species and how similar it could be for distantly related species. Hmm. So for instance, the domestic cat and its relative, the Gen A cat gets around 12 and a half hours of sleep. Okay. Like I said, a day with 3.2 hours rem and a gen gets about half that 6.3 hours with 1.3 hours rim. And those are like closely related species.

EAU: Yeah.

EW: Yeah.

EAU: Is that just like, 'cause domestic cats are just. Chilling house.

EW: They, they might be just domestic cats. Yeah. Yeah. Uh, but then there's also a golden mantled ground squirrel. Okay. And a de gu, again, closely related the squirrels 15.9 hours. Whoa. Sleep good for

EAU: them of sleep

EW: with three in REM and 7.7 for the daegu with 0.9 in rem.

EAU: How interesting.

EW: So it's not just about like domestication, right. Although I'm, I'm assuming that is a decent part of it for the cat.

EAU: Yeah.

EW: Uh, then take a Guinea pig and a baboon not closely related, but their sleep architecture is, or they're not architecture, their sleep like, uh, duration and REM proportion is very similar. They each get about 9.4 hours of sleep and one of rem

EAU: That's so interesting.

EW: And in case you were wondering for humans, humans, we humans get the same amount of sleep as an Eastern American mole. We get seven to eight hours and we both have about two hours sleep. REM.

EAU: Oh my gosh. Interesting.

EW: Isn't that funny?

EAU: Yeah,

EW: it's really funny. But among primates though, humans are the exception. We are at the very extreme end of sleep duration with some of the shortest sleeps of all primate species. Oh, interesting. The the shortest sleeps. Yeah, the

EAU: shortest sleep of all primates.

EW: Yeah.

EAU: Huh.

EW: Yep. On the other end of the spectrum are, uh, owl or night monkeys. Owl monkeys are night monkeys, which sleep about 17 hours, but they get the same amount of REM sleep as humans.

EAU: That is so interesting.

EW: Yeah.

EAU: Oh, I do wanna look so much more into REM now.

EW: I know, right?

EAU: What is up with that?

EW: I know what is up with that sleep. What is up with that?

EAU: Yeah.

EW: Based on our human body size body, ma or brain size, body mass, predation, [01:05:00] risk, forging needs, sexual selection dynamics, diet and what we know about other primates like researchers have kind of compiled this model to be like, how should we ex, how should we expect humans to sleep based on what we know about all other primates? Okay. And that comes out to nine and a half hours a night.

EAU: That's how much we should be getting

EW: based on that's how, based on these that is not. And, but we, on average it's six to seven hours for humans. Yeah. And this does not mean that we should all be sleeping nine and a half hours. No, no, no, no. It's just what the model predicts based on Yeah. Other primates.

EAU: So it shows that we are weirdos.

EW: Yes. Because evidence, I mean, evidence points to six to seven as normal sleep. Yeah. Or six to eight is normal sleep in humans. And it might just be that we somehow squeezed our sleep into a shorter duration, like we're more efficient or intense sleepers.

EAU: Interesting.

EW: Other great apes sleep a bit more than humans, but less than like night out or night monkeys. And like chimpanzees get about 10 hours with similar REM as humans and gorillas sleep about 12 orangutans, sleep about nine. Slightly rest less than humans. But, um, when it comes to humans and, and other great apes, we do share other characteristics. Okay. Uh, so like we have this high proportion of REM sleep. We have nesting behavior.

EAU: Mm-hmm.

EW: Which I just think is adorable. Many of the over 400 primates species that exist sleep in trees. Okay. Whether that's in tree holes or on bare branches, just like balancing up there. Mm-hmm. Even if they spend like much of their waking time on the ground, uh, they will sleep, you know, up the tree up in the trees. And this might help with like predator avoidance. Probably other species might sleep individually or they might sleep in groups, or they might sleep on bare ground or on cliffs like baboons sleep on cliffs. Okay. And on bare grounds. And some build nests mostly in trees. In fact, all great apes build nests, all of them.

EAU: I did not know that.

EW: Yeah. Me either. Yeah. And so this suggests that the behavior emerged about 14 to 18 million years ago.

EAU: Interesting.

EW: They are built individually. They take between one to seven minutes to construct and they're usually built every night, every night with occasional reuse.

EAU: So they just make their own new nest

EW: every night. They make their own new nest. Yeah, with a bunch of different materials. It's, there is so much more about nest building. And I have a paper too.

EAU: That's

EW: so cute. And so why did we start to build nests? It's thought that as body size got bigger in these great ape species, they probably helped to make sleeping more comfortable overall and to protect against damage. If you like fell out of a tree, then like your body was just like ccho. You got a

EAU: little cushion

EW: there, you got some cushion. So like your Yeah, it makes it more comfortable. Um, and so this also helped to avoid predation. So research suggests that chimpanzees build nests higher and in closer proximity to each other in places when there where there are more predators.

EAU: Ah.

EW: And also thermo regulation. So you can decide, okay, is your nest placement gonna be higher up or lower down? Do I need more insulation? Do I need to pack in some more leaves? Is it leaves, is it a chilly night? Is it nice and warm? You know, like, I wanna get a breeze up in there.

EAU: Yeah.

EW: And finally, nests may also help to deter biting insects. So researchers found that some orangutans built their nests near naturally rep mosquito repellent tree species when mosquitoes were abundant.

EAU: I love this so much.

EW: I know. I mean, if you think about it, nest building is an incredible behavior and there are some researchers that categorize it under tool use. Mm-hmm. Which would make it the most pervasive among great apes.

EAU: Wow.

EW: Yeah. Um, it's environmental problem solving when it comes down to it. Yeah. Did great apes build nests because they were smart? Or did building nests help make evolve, smartness evolve, enhanced cognition? This

EAU: is such an interesting question.

EW: Yeah. Chicken or egg, I don't know. Yeah. I don't know. But so like I mentioned, most of these nests are in trees, but humans have long slept on the ground, despite the ground making us more vulnerable to predators. And some researchers have suggested that this ground sleeping with its more stable surface would've enabled even deeper sleep. Mm. Which then allowed us to sleep more intensely. Efficiently. Because efficiently, we're not gonna

EAU: fall out of a tree.

EW: Right. We don't have to have that increased vigilance. Yeah. As much. And so that's what maybe allowed us to shorten our sleep duration. And then once humans developed the ability to control fire, that would've cut down on the risk of predators. Mm-hmm. And biting insects. And it would've increased our thermo regulation capacities, Uhhuh, while allowing us longer hours to socialize into the night, exchanging ideas and storytelling. Maybe even promoting the

evolution of language. And so in short, sleeping on the ground helped to make us become human.

EAU: Oh my God,

EW: right? Once we made it there on the ground, what happened then? Did we just stick to our six to eight hours a night with no breaks? Or is the story slightly more complicated than that? Tell me, I'm leaving you on a cliffhanger. Okay. So you'll have to tune in next week to find out, [01:10:00] but I hope you like this little hodgepodge of a tour through Animal Kingdom sleep.

EAU: I loved it.

EW: It's not a mistake.

EAU: No,

EW: sleep is not a mistake,

EAU: is not an evolutionary mistake.

EW: I think that was mostly said tongue in cheek,

EAU: but yeah, I totally sounded like it.

EW: Yeah. Yeah, yeah.

EAU: Oh, that was really fun and it made me really excited to find out what humans did with our sleep.

EW: I can't wait to tell

EAU: you because obvious. I mean, I don't sleep on the floor.

EW: I don't sleep on the floor. I have slept on floors

EAU: many times.

EW: Yeah. It's not my preferred method or in port benches. It's horrible.

EAU: Yeah. So I can't wait to hear what we did with sleep.

EW: Uh, well, in the meantime, there's a lot more reading. Oh my gosh. That you can do. Shall we tell the people where to read?

EAU: Let us tell them.

EW: I have many sources, many sources for this one. I can't

EAU: wait

EW: because I just kept going down rabbit holes. I

EAU: loved

EW: them

EAU: all. We didn't even talk about rabbit sleep. We didn't. But

EW: I actually did have a section where I was, I went through each of the animals on my, on your shirt PJ's to be like, raccoon, sleep this amount, uh, possum sleep, this amount, my favorite animal besides the Tasmanian devil, squirrels, et cetera. And I cut it. So I was like, it's too much. It's way too many animals. Okay. You can find more information. Mm-hmm. There's a book, uh, about a lot of animal sleep called Evolution of Sleep, phylogenetic and Functional Perspectives by McNamara ET All from 2010. Then there's a great paper I love from 2008 called Unearthing the Phylogenetic Roots of Sleep by Al and Seagull from 2008, I think I already said, 2008 multiple times by lineman et al from 2008 as well. Cean sleep, an unusual form of mammalian sleep, and finally by Fru and Stewart sleep and Nesting behavior in Primates, a review.

EAU: Love it.

EW: Great stuff.

EAU: I had most of this information that I shared came from a book from 2012 that was called Sleep, A very short introduction from Oxford University Press. Um, it, it is, it covers all the bases. Um, but I also enjoyed a paper from physiological reviews from also 2012. That's weird. Um, that was called Control of Sleep and Wakefulness by Brown at all. And then the paper that was not funded by industry about the wearable finger tracker ring sleep measures was from Scientific Reports published this year, 2025.

EW: Trying so hard not to say any brand names.

EAU: I know you know the ones, um, I guess 2025 is last year by the time this comes out doesn't matter. It's fine. Anyways, it was by Herberger Etal and it was titled Performance of Wearable Finger Ring Trackers for Diagnostic Sleep Measurement in the Clinical Context. But I have other ones as well too, and so many more papers so you can read them all and find them all. On our website, this podcast will kill you.com.

EW: We will post them all there. Yep. Uh, Steven Ray Morris, thank you again, Steven Morris. What an absolute delight.

EAU: It was really, thank you so much for sharing your story.

EW: Also, sorry that you've had sleep paralysis. I know we're not saying your sleep paralysis was a delight.

EAU: No.

EW: Hearing your voice share, hearing your, you share your story. It was wonderful. Thank you. Thank you. And thank you also to Blood Mobile for providing the music for this episode and all of our episodes.

EAU: Thank you. Thank you, thank you to everyone here at exactly right studios. Thank you. Thank you. Uh, as well as everyone who helps make this podcast possible.

EW: Yes. Uh, including you listeners, thank you for listening. Patrons, thank you for Patron. Your patronage.

EAU: Your patronage. That feels,

EW: yeah.

EAU: Yeah.

EW: Thank you for everything.

EAU: Thank you.

EW: Wow. Uh, until next time. Wash your hands.

EAU: You filthy animals.