Let's Talk About Light and Health – A new kind of lullaby: Robust light/dark pattern for babies

Sofia Axelrod, PhD, Randy Reid, MBA, Allison Thayer, MS

" This interview is part of our Let's Talk About Light and Health series, and the name of this session is A New Kind of Lullaby: Robust Light/Dark Pattern for Babies."

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Randy Reid: This interview is part of our *Let's Talk About Light and Health* series, and the name of this session is *A New Kind of Lullaby: Robust Light/Dark Pattern for Babies*. Dr. Axelrod, welcome.

Dr. Axelrod: Thank you for having me. I am very excited to be here.

Randy Reid: Well, we're very excited to have you, and the first thing I have to do is: tell our audience a little bit about the Nobel Prize you won in 2017.

Dr. Axelrod: It wasn't actually me who won the prize, it was my mentor Michael Young, and he basically discovered a long time ago in these little fruit flies that we have genes in our bodies that control when we sleep, when we eat, anything that really happens in our physiology. It turns out that humans have the same exact genes. And that's what he won the Nobel Prize for.

Randy Reid: Tell the audience a little about your background.

Dr. Axelrod: I studied biology, and I've always been fascinated by how our bodies work, and as I studied, I realized I wanted to dig deeper and understand the genetics and molecular biology and the cell biology of what really happens in our bodies. I later realized that people now even study behavior with these tools of genetics. So I joined Mike's [Young] lab to basically use these molecular tools to dissect something as complex as sleep. I figured we might as well use something as simple as a fruit fly to do this because we believe all animals sleep, including fruit flies, so you might as well understand it in them and then translate it potentially to something as big and complex as a human. I was working in the lab and making progress on my project around the fundamentals of why we sleep and how we sleep, which is actually not clear. We do it every night, but we don't necessarily understand from a scientific perspective what happens in the body and how it's really regulated. That's what I was studying in the lab at the time that I became pregnant. I should say that I have actually been a life-long insomniac and when I joined this laboratory at Rockefeller, and I was learning all about sleep and circadian rhythms, I understood what I had to do to help myself sleep better, so that was one way of taking the knowledge from the lab and applying it in the real world.

Randy Reid: Let's expand about that because I saw on your biography that you are a lifelong insomniac, and you had a baby, and you thought you'd never sleep again. What did you discover and tell our audience how that led to some of the workshops that you did and eventually the book you published?

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Dr. Axelrod: One of the things we know from research is that light really matters when it comes to circadian rhythms. Light is the thing that tells our body what time it is. By manipulating light in our environment, either by going outside or using specific types of lighting, we can affect our circadian clock. In the lab, we use that every day because we have our lab animals, but the same thing happens in humans. When we don't want the study subject (whether it's a fly, mouse, or human) to experience the effects of light, but we still need to see, we use red light because red light does not affect our circadian clock. I was standing in our dark room with the red flashlight because I was handling my experimental flies, and I was quite pregnant. And I thought: 'Why don't we use red light to help babies sleep?' All life responds the same way to light, whether it's a fly or babies. Often night lights for babies are blue. And blue lights actually activate our circadian system and tell us to be awake, so it's like the opposite of what we want if you want your baby to sleep and if you want yourself to sleep. So I got a bunch of red light bulbs and installed them. I also thought it helped me wind down at night, which makes sense because it naturally increases your melatonin release. And when I had my first daughter, I used the red light at night for any night wakings and whenever I had to placate her or change her diaper. I

only used red light. I used a lot of light during the day and at night, only red light, to entrain her circadian rhythm, and it worked really well because it's our biology.

Dr. Axelrod: Then I thought, 'Okay, what else do I know? What else can I use from my knowledge as a sleep scientist to apply to her sleep?' there are a couple other things that are very clear to us as scientists that have not made it out to the real world. One, for example, is that there is this notion that sleep begets sleep. That a baby needs to sleep a lot during the day to sleep well at night. And that goes against everything we know about sleep science of sleep needs. We have a total daily sleep need that is daytime sleep plus nighttime sleep. If I put you down for a 5-hour nap during the day, you're not going to be tired at night. The same is true for babies. It's just more confusing because they get tired more quickly, so they do need to nap. But make sure to keep that in balance so you can maximize nighttime sleep. So I researched that, and I figured out how much at every age a baby should be sleeping to sleep better at night. That was basically the second big idea that made it into my method. Generally, just about circadian rhythms, the idea that we have an inner clock that is either reinforced by things that we do, like getting up at a certain, like eating at a time or is weakened like if we do erratic wake times, erratic feeding times.

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Dr. Axelrod: There is this notion in parenting that you should let the baby decide when to eat, when to sleep, [and] when to do whatever the baby wants because it seems too intuitive to do this "baby-led parenting," as it's called. But it doesn't make sense from a circadian perspective, and there's data that shows that you can help babies sleep through the night and be generally happier by helping them get on a schedule.

Those are the three things that I synthesized from my knowledge as a sleep scientist and chronobiologist. Control light exposure, watch the sleep need and keep the circadian rhythms going.

Dr. Axelrod: The other thing that is really divisive in the parenting community is "sleep training." A lot of people think that sleep training will harm your baby and that if you let a baby cry.

Randy Reid: What is sleep training?

Dr. Axelrod: All these things that I just mentioned will naturally help the baby sleep more at night. But there is one more thing that I have to talk about, and that is the ability to fall asleep at all. Which is not something that we are actually born with. It's a skill that we learn. We need to learn to be able to put ourselves to sleep. That's something that babies struggle with, and that's why they cry. We need to teach them to fall asleep, ideally on their own, if we want to sleep ourselves. If we teach them to need you to fall asleep if you teach them to need a nursing mother to fall asleep, or anything else really. Some people call that "sleep crutches." If a baby needs to sleep on top of you, if a baby needs to be carried around, if a baby needs to sleep with you, then the baby learns that this is what is required to fall asleep. That becomes their mode of sleeping. I'm, for example, a person who is a bad sleeper, a light sleeper; I just can't sleep if someone is touching me or crawling on me. For me, it was paramount for me to solve that. Other people, like my husband, he doesn't care.

Dr. Axelrod: If it's important for you that you have a good sleep at night, then you need to teach your baby to fall asleep on their own. You do that with the things I mentioned earlier: control the light, entrain their rhythms, and watch the naps. But there's one more thing, and that's sleep training. It's a very controversial idea. I don't even want to call it "sleep training" anymore. You can call it whatever you want, "teaching them to sleep through the night." You need to teach them to fall asleep on their own. It's also called "self-soothing." It's the ability to lay down and calm down and close your eyes and believe that you can make it fine on your own to fall asleep. The most effective way that has been studied rigorously to accomplish that is called "sleep training." The idea is super simple. It means when it's the baby's bedtime, and baby needs to sleep, and baby is fussing or crying, but you are sure that they're fussing and crying because they're tired and need to sleep.

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Dr. Axelrod: Instead of somehow intervening and trying to make the baby not cry in that situation, you just let them be. You let them be for how long; it kind of doesn't matter. There are studies that say waiting just 90 seconds is enough. That's what I recommend in my book because I know how hard it is for a parent to hear their baby cry. Just by waiting 90 seconds each time, though, because you want to teach them that this is what's going to happen now. You're tired, you need to calm down, and you can do it. You don't need mom or dad. You don't need anyone; you can do it by yourself. So just waiting 90 seconds, the baby learns, "It feels uncomfortable, but I can do it." Research shows that this is highly effective in teaching your baby to sleep through the night. There are no negative side effects; there are no long-term consequences**.** Actually, there are positive consequences. It has been shown that parents are happier and sleep better. Children grow up to be well-adjusted kids who have no mental health problems or anything like that and do well at school.

Randy Reid: What if they continue crying after 90 seconds, it goes to two or three minutes; then do you go in?

Dr. Axelrod: Exactly, so my method, I call it actually "gentle sleep training. "On its surface, it's gentle to the baby, but really it's gentle

on the parent because I was the parent that was sitting at the edge of my bed counting the seconds until my own method told me I can finally go and help that baby. We're biologically programmed to do that, so to not do that feels horrible. So I go in after 90 seconds, and I pat the baby, and there are these ideas that are just shushing and patting them comforts them, and then you do this for a few minutes, and then you leave again. The cycle the first time you do it might take a long time, like up to 45 minutes. Relatively speaking, 45 minutes is not a long time, but 45 minutes of crying is hard. So I tell the parents I work with to be ready for that; this will be excruciating, but just trust the process and the data that show that this will work. Typically after one to two nights, this is just over, and everybody gets the sleep they need, so I really encourage people to find the inner strength to bear with it and to do it.

Dr. Axelrod: There're all kinds of tricks around how to make it easier. It certainly helps to do this earlier than later because if a baby is already a year old, they remember, and they're not going to be happy about the sudden change that occurs in their sleep routine. If they're used to being nursed to sleep, they'll be like, 'where is my boob,' if they're used to co-sleeping, they'll be like, 'why am I supposed to sleep on my own?' For a three-month-old baby, it's a much easier proposition. So doing it earlier rather than later is easier. Using your partner who, if you're nursing, is not nursing, is easier because the baby smells actually the milk on the mother, and if they're used to being nursed to sleep, they'll be like, 'what, you're trying to placate me without nursing me? That doesn't make any sense." So there're all kinds of things to make this easier. Also, "evicting," I call it, harshly evicting the baby from your bedroom helps with this short delay because if the baby is right there crying, it's very hard to not tend to them so just creating a little bit of distance helps. So there's a bunch of things we can do.

Randy Reid: What about sound machines? I haven't heard you mention that. Is that a crutch, or is that okay?

Dr. Axelrod: I consider "crutches" anything that impairs my ability to get sleep; therefore, a white noise machine is totally fine. In fact, there is pretty good evidence that they also help the baby sleep. Which is interesting, right? Why would noise help someone sleep? But we actually think it's because of the noises the babies experience when they're still inside of the mother's body. It's actually quite loud in there, and it seems like white noise might remind them of this cozy environment. Which is the same reason, by the way, why swaddles are so effective. Young babies/newborns have these reflexes where they keep waking themselves up, and just by doing this, you're kind of making them more tired, and they don't wake themselves up when they have this moral reflex.

Randy Reid: What about the 'Snoo?'

Dr. Axelrod: The 'Snoo' is based on a pediatrician's method of how to put babies to sleep. His name is Richard Ferber, and his method has become so popular. And his book was and still is, of course, is one of the bibles of baby sleep, and he actually came up with the idea of "Ferberizing" a baby, which is to soothe them to sleep. And that you can help a baby sleep by shushing, by swaddling, and there's like a couple of s's, and the Snoo does them all. The Snoo swaddles the baby, the Snoo will shush the baby, and the Snoo will rock the baby because movement is another one that puts the baby to sleep. Again probably because they were rocked in our bellies when we were pregnant, and the Snoo does all these things; and in an automated fashion. I think it makes total sense. It's a very expensive thing, but then again, your sleep is also very valuable. So this can really help a lot of people in the first couple of months, which some people even call the fourth trimester because the babies are really small and, like I said, can't put themselves to sleep yet. It wasn't out yet when I had my kids, but if it had been, I probably would have gotten it because, you know, you're just a zombie, and this tool seems to be working quite well for a few months. It helps basically with the fourth thing that I described, but I think it's important to still do the other things [we discussed earlier]. Otherwise, you have a baby that will wake up at night, and you have your Snoo to take care of that, but once they grow out of the Snoo, which happens very quickly because it's just really a bassinet for the first couple of months, then your baby will not have a good sleep cycle, and then you have to deal with that so it can be a problem if the parents don't really do any of the other things that are important to teach a baby's body to be tired at the right time.

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Randy Reid: Do you have an app that you've created?

Dr. Axelrod: Yes, so I really want to help parents in a way that addresses all their needs. Not everybody will be able to absorb my book in a way that helps them solve their baby's problems, so I thought, 'okay, let's forget about all that. Let's just make an app.' You don't have to ever have heard about my lofty ideas, you just put in your baby's age and a few other parameters that I've identified are relevant for baby sleep, and the app will simply tell you what to do. It will tell you exactly when to put the baby down; it will tell when to wake the baby up, what to do with the light, and how to sleep at night. Just do what the app tells you, and your baby will sleep. So that's what I did. It's called "Kulala," and people really like it, I think.

Randy Reid: What does that [Kulala] mean?

Dr. Axelrod: Kulala means 'sleep' in Swahili. I don't have any relation to it, but I thought it also sounded really cute, like a lullaby.

Dr. Axelrod: Also, in terms of the light, I actually wanted to point out that aboriginal communities in Africa don't have a lot of the sleep problems we have because they have a much stronger light/dark cycle. They don't have this constant dimness that we have during the day and the enhanced brightness that we have at night, so there is something there.

Randy Reid: What is the name of your book?

Dr. Axelrod: My book is called 'How Babies Sleep,' and it's actually been translated now into 11 languages. Here's a Japanese version. I've just been to Italy for a sleep conference last week, and I went to a bookstore in Florence, and they had my book, so that was a big rush. It's helping parents worldwide, and it's just incredible.

Randy Reid: Can we buy that on Amazon? We don't have to go to Italy, correct?

Dr. Axelrod: You don't have to go to Italy; yes, you can buy it anywhere that books are sold.

Randy Reid: You also have a light that you sell, is that correct?

Dr. Axelrod: Yes, that's right. I used these red light bulbs when I had my kids, but they're not really something that parents are going to use unless they're really dedicated, you know, going to a hardware store; it's just not an attractive, easy-to-use product for a parent. So I wanted to make something, mostly for myself, but of course for everyone else too; to have a nice lamp that only does the one thing, which is to provide the light that does not suppress a baby's melatonin because we want that sleep hormone to be high at night. So we made this beautiful all wood lamp. It only emits light in the right wavelength, which is above 650 nanometers. It's the perfect thing to compliment my method, so you have the book to learn all about it, you have the app to know when to turn the light on, and then you have the light to turn on when you have to placate baby at night when they're crying or when you are nursing or when you're changing a diaper.

Randy Reid: Where can our audience buy that lamp?

Dr. Axelrod: We have a website called "kulalaland.com," and that's where you can learn about what we're doing and you can buy my lamp. You can actually buy what we call our "Kulala Sleep System," which is the lamp, the book, and six months of the app subscription, so you have it all together in one package like a starter package. If you're pregnant or if you're a sleep-deprived parent, to get you out of that or as a baby shower gift.

Randy Reid: Regarding the lamp, is it LED technology in there?

Dr. Axelrod: Yes, LED technology has revolutionized lighting, and this is our chance now to really create lighting products that correspond to our physiology because our eyes are highly sensitive to very specific wavelengths, and lighting like incandescent lighting just can't achieve the precision that LED lighting can. So this lamp is engineered to really only have wavelengths above 650 nanometers, so it's completely safe. It does not activate the ipRGCs, which are the cells in our eyes that respond to blue light. So you can be 100% sure that this is inert for our circadian system. I use it every night, actually.

Randy Reid: Beyond sleeping better, are there any other impacts of light on babies' health?

Dr. Axelrod: Yes, of course, so sleep is really just one of what we call 'outputs' of the circadian clock. It's an important one, but it's only one. In fact, the more we learn about it, we realize that everything that happens in our body is on the clock. Whether it's body temperature, whether it's hormones, whether it's bowel movements, but also things like mood and even for babies growth. **There's data that shows that NICU babies (so, babies that are born prematurely) grow faster with circadian lighting. By making the differences between daytime and nighttime in terms of light very strong, you can make a baby grow faster, so the effects go beyond sleep. Sleep is very important mostly for the parent. The baby doesn't care whether they sleep during the day or at night, but the parent cares a lot. But having a strong circadian rhythm and light is part of that, and sleep is part of that will help the baby grow and be healthier and happier.**

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Randy Reid: If a baby is raised without any concern for circadian entrainment whatsoever and is getting fluorescent light at night and they're just growing up that way, are there long-term damages, or can that be fixed at a later age?

Dr. Axelrod: I don't know, because that's research that's I don't even know if anybody's doing a longitudinal study like that. That's actually something I would be very interested in studying, but one thing is very. The function of the circadian rhythm is basically for us to know what's going to happen next, so if you have a strong circadian rhythm, your body just knows 'I'm going to get food, I'm going to have lunch,' and it starts preparing your digestive system and starts secreting enzymes. Or your body knows, 'I'm tired and cranky, and I'm gonna get sleep, so I'm gonna fall asleep now.' If you don't have that because of erratic behavior or erratic lighting and all of that is collapsed, your body constantly doesn't know what's happening, and your body is not as well organized. That will have detrimental effects on your health, and there is research that shows that, for example, constantly phase-shifting people, business travelers, or shift workers have serious health problems. You would imagine that starting like that early in life when your organization is even more dependent on a structure would have

negative outcomes.

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Dr. Axelrod: I've become totally obsessed with light and chronobiology, and I used to be a scientist who didn't care about applications at all. I just wanted to know how stuff works, but this is such a simple and powerful tool that we can use to make ourselves sleep better, feel better, and be healthier. I think it's really important that people understand that and that companies create products to help achieve that. I'm sitting inside here, and it's really dim. The lighting inside is ten thousand or a thousand times dimmer than outside, and that's why we get sick. And at night, we stare at our screens, and it's much brighter than it should be. So, you know, it's so easy. It's just a light, and it will really help us live better. I think it's exciting that people are working on this and that people are researching it. We have a bright future ahead of us if we use what basically nature has provided us with.

Randy Reid: Well, Dr. Axelrod, thank you so much for speaking to our audience today, and please stay tuned now for a few questions. Thank you.

Randy Reid: Dr. Axelrod, thank you very much for that; we will now open the floor for questions. I'd now like to introduce our producer of Let's Talk About Light and Health, and that is Allison Thayer, and Allison will moderate the questions.

Allison Thayer: Thank you, Dr. Axelrod, for that interview too. That was really interesting. We want to open up the floor to parents, anybody who's going through this, and we'd love to hear from you.

Allison Thayer: If you don't mind, though, I actually have a question myself. You talked a bit about entrainment of sleep, which is generally getting your body to be awake during the day and to sleep at night. From other talks, we've learned that bright light during the day and then that dimmer light at night or that red light that doesn't suppress your melatonin is really important to have at night so that we don't disturb our circadian clocks. But then, for babies, I'm wondering about napping during the day. Can you talk a bit more about a lighting schedule for babies that is during the day? How does that fit in with a nap schedule, and do babies have the same effect that we have from light during the day?

Dr. Axelrod: It's confusing to parents because they don't have the same sleep/wake pattern like we do that would nicely fit together with our circadian rhythms and everything. I just talked about in terms of lots of light during the day, no light at night, and sleep at night, but babies do sleep during the day, so what does that mean? That goes back to the other kind of system I described, which is the sleep pressure. Babies' sleep pressure rises a lot quicker than ours, so yes, they do need to sleep during the day. That's somewhat decoupled from the circadian rhythms, ergo, that means for the lighting my recommended (nobody has studied this specifically, but) if we go back to what circadian rhythms are doing and how light entrains our circadian clock, you would not want to necessarily (especially for newborns) put them in complete darkness for naps. Especially in the very early days, it's really important to establish these very robust patterns and make the day as different from the night as possible in terms of light. For example, where the baby is sleeping, I would always put them at night in the exact same spot, complete darkness, very quiet. But during the day, I wouldn't actually do all these things. I wouldn't keep it too quiet; I wouldn't make it too dark. So the baby of course, can [still] nap, and we want to encourage that, but also that the body and the baby from day one understand on a physiological level that daytime sleep is different from nighttime sleep. Otherwise, if you provide the perfect sleep environment during the day, you will end up with a baby that potentially sleeps too much during the day, and that shortens nighttime sleep. That's the people who come to me and say, "my baby sleeps six hours during the day and doesn't want to sleep at night; why?" So you can, you can lay that foundation in the early days.

Randy Reid: How important is it for the baby that the mom is getting proper light/dark cycles during pregnancy?

Dr. Axelrod: That's a great question. The research on this is developing, but all data that I know of indicates that it's the mother's circadian rhythm that, even during pregnancy, already informs the fetal circadian rhythm. There are also peculiarities about a pregnant woman's circadian rhythm. They shift earlier in early pregnancy, which is interesting, but overall the recommendation would be, yes, you should try to already before you give birth to try to entrain yourself. It's quite likely that will entrain the unborn baby, and then when they're born, they already have a more robust circadian rhythm.

Allison Thayer: That fits in with the next question from Robert: What do we know about the sleep architecture of babies throughout the course of the day? Is nighttime sleep different than daytime sleep? We kind of answered that a little bit, but do you have anything else to comment on that?

Dr. Axelrod: I don't know that there is a lot known about that, but I think in terms of our sleep (which ultimately is my goal of maximizing), I operate under the assumption that there is not a big difference in terms of sleep quality. Babies need a lot of sleep, and there are interesting studies coming out around, like how sleep is fundamentally different in young babies from older children. We think in young children, sleep has developmental functions that sleep for us [adults] doesn't have because we're fully developed, but that being said, there is a lot of flexibility on our part in terms of what we decide when a baby should be sleeping. You have more

power than you think in deciding when a baby should be sleeping, and you can kind of align it, not completely, of course, but you can shift the baby's sleep to align with your schedule and light, and sleep pressure are the two knobs we can turn.

Dennis Spaulding: We have already spoken about this a little bit, but I was curious about babies, and my son was a problem sleeper, or maybe it was myself with his training. Do babies need a certain time during the day, either after the nap or something like that, where they would really benefit from bright light, so to speak, to entrain them?

Dr. Axelrod: Great question. Nobody knows that, but the fact that babies are so sensitive to light, and we don't know really why (some people say because their eyes are more clear), and it's very clear that bright light at night wipes out their melatonin. So nobody tested that you can also help with sleep at night and with your circadian rhythms by providing more light during the day, but everything we know about circadian rhythms would suggest that, yes, you would want to expose baby to plenty of light during the day. Go for a walk and things like that. Also, for naps, don't make it too dark, especially for newborns. They will sleep wherever. I can't tell you a specific regimen in terms of how much light, but I would recommend as much as possible. Some people live in apartments or houses that don't have a lot of natural light. That's something I would pay attention to. There is no solution right now for lighting that would generate outdoor lighting conditions indoors, apart from these seasonal affective disorder lamps. Nobody has tested how babies react to that, but you want to generally increase the amount of light a baby has during the day based on your general understanding of circadian rhythms.

Allison Thayer: To clarify, do you want red light during the day, or do you want a different type of light

"No red light during the day. For all the reasons I just explained. I call it night-mode and day-mode, and the red light is in night mode. So, either in complete darkness or if you have to see because you need to placate your baby or you need to change a diaper, red light is safe."

Dr. Axelrod: No red light during the day. For all the reasons I just explained. I call it night-mode and day-mode, and the red light is in night mode. So, either in complete darkness or if you have to see because you need to placate your baby or you need to change a diaper, red light is safe.

Dr. Axelrod: But during the day, older kids do need certain conditions to be able to nap, so you can't just put a two-year-old in a bright, loud room. For sure, we have to help older kids to sleep better, but I would leave the red light out of it. Typically anyway, during the day, usually no amount of blackout shades can, you know, create the complete darkness that we have at night, so the red light is kind of useless for that. Anyway, we wouldn't want to use the red light in that way. We wouldn't want the complete darkness and red light during the day because we don't actually want melatonin to go up during the day

So the next question we have from Mark: "Do babies have weekends that follow their parents' shift from weekday working to weekend socializing, and what would a babysitter do? Do we keep the baby on the workday schedule?"

"So if you had a really good schedule during the week and your child's and your own body now really know 'at this-and-this time I'm tired, I'm going to sleep.' Everything is aligned, and the sleep hormone is working to your advantage, and then it just all erodes over the weekend, then all that just goes away a little bit, and then your body doesn't know anymore what's going on."

Dr. Axelrod: Great question. Very important to not do that. It's super important to not change anything. Nobody wants to hear that, right. On the weekend, you just want to sleep in. That's something I actually ended up fixing about my own sleep when I joined Mike's [Young] lab, and then for my kids even more so, you don't want to do that [change your schedule on the weekend]. You want to be really on the clock and on the weekend, not shift (which would basically introduce jet lag or social jet lag into everybody's body's schedule). The problem with that is it overall just weakens the circadian rhythm. So if you had a really good schedule during the week and your child's and your own body now really know 'at this-and-this time I'm tired, I'm going to sleep.' Everything is aligned, and the sleep hormone is working to your advantage, and then it just all erodes over the weekend, then all that just goes away a little bit, and then your body doesn't know anymore what's going on. And your baby's body doesn't know anymore what's going on. What does that mean? They'll be sort of sleepy and cranky because their sleep needs and their sleep pressure is not aligned anymore with circadian rhythms, and so as annoying as that is, I totally advocate for not changing anything ever. Caregivers, get them all on the same page, tell them what's going on, tell them that you have that schedule and why you have that schedule. Don't let the grandma let the baby sleep all day. A struggle I had personally is, for example, in the daycare where sometimes they just nap for hours and hours and then those nights after daycare, suddenly bedtime ends up being much much later, and parents are like 'why is that and what can I do about that?' The only thing is to shorten that [naps], and overall you don't want the weekends to look different from weekdays. You want everything always to be the same, as hard as that is. That is kind of an organizing principle that if you follow that, everything else becomes easier. That's why I would advocate for that.

Randy Reid: How long before bedtime should we limit screen exposure for toddlers?

Dr. Axelrod: That's another big one. Even earlier [when a child is

younger], like when you're feeding a baby, that can take a long time, and what does a mom do when she's, for example, nursing a baby? She's on her phone, and I think that's totally valid, and I don't want to take that away from anyone. The good news is, we have tools to make the screens dimmer, and we have these filters now that are now built into IOS and also Androids that make the screen filter out the blue light. On top of that, you can find additional apps that make it even red. I'm very strict about this, so I actually have an app that makes the screen red. So you don't need to limit screen time, but if that's something that you need as a last resort because the kids are going crazy and you want them to watch their show for half an hour, that's fine. Just make sure if it's on the iPad to make it dim and yellow or even red. If it's a TV, it's much harder. I actually have on the TVs in our apartment different modes that I manually installed that are very dark. You can actually, if you're so inclined, filter out the colors, but it's not easy. So if you can't, if you don't have these tools to filter out the blue light, then I would stop doing any screen time one hour before bedtime. Not much longer, actually, because this is quite dynamic.

Randy Reid: Is it fair to say that a baby's day is shorter and they should have more cycles in 24 hours than adults?

> ***" One of them is circadian rhythms, and the other is sleep pressure. For adults, these two things just come together; and our sleep pressure is very high and needs to be filled once a day, and our circadian rhythms are 24 hours, so it fits together. For babies, they just need to do that more often because their sleep pressure rises much quicker, but their circadian rhythm is still 24 hours."***

Dr. Axelrod: That's an interesting question. It might seem like that if we use sleep as kind of an indicator of circadian rhythms or how many times we sleep, right. You could say if we sleep one time in 24 hours, then our circadian rhythm is 24 hours, but a baby sleeps five times. Maybe its circadian rhythm is only five hours, but that's not the case. So that speaks to these two processes that really determine sleep timing. One of them is circadian rhythms, and the other is sleep pressure. For adults, these two things just come together; and our sleep pressure is very high and needs to be filled once a day, and our circadian rhythms are 24 hours, so it fits together. For babies, they just need to do that more often because their sleep pressure rises much quicker, but their circadian rhythm is still 24 hours. I would say that baby's circadian rhythm is just like ours. It's weaker, and it needs more entrainment, which is why all these things are extra important. In adults, our daily sleep, which happens only once, is actually another thing that entrains our circadian rhythm in a way. You can think of anything we do or don't do as either strengthening or weakening our circadian rhythm, so light is just one of them. Food is another one but sleep itself or when we are active, when we're moving, when we're not moving is another one. The erratic nature of babies' sleep-wake patterns also weakens the circadian rhythm, but their circadian rhythm itself is still 24 hours, so we have to work with other aspects of the circadian rhythm to increase the amplitude because sleeps will not do that. The sleeps [naps] are much more often than every 24 hours.

Allison Thayer: That makes a lot of sense, and Trisha's question kind of fits in with that. Trisha, would you like to ask yours?

Trisha Odenthal: Hello, I have a niece and a friend's children. What's the nap time length for three months, one year, two years, and three years? When do they abandon naps? How long should they be?

> ***" Parents/grandparents are very worried about waking a sleeping baby, and I give you permission to do that. It's okay, and the baby will be fine, and they will sleep better at night because we have this total sleep need. "***

Dr. Axelrod: That's another huge source of confusion for parents, grandparents, and caregivers on top of everything else we just discussed. Sleep needs in babies changes so quickly that it's hard to stay on top of it, and a baby that slept last week might not sleep well this week anymore. And what I've found, and there's solid evidence for that, is that it's usually because their sleep need is going down. It's going only one way. Babies are different, sure, but all babies sleep more when they're younger than when they're older, right? We [adults] sleep between, whatever six and eight hours, and babies sleep 20 hours when they're born and already only 12 hours (in 24 hours) when they're one year old. So there're huge changes happening, and it's really hard to understand what's going on. Now, the good news is that people have tracked baby sleep, and we know pretty precisely how much babies sleep at any age group. One can just map that out, and then the thing is, yes, there is your variability between babies. So I can tell you the average for each age, and then your baby's sleep might be a little higher, a little lower, but what's clear is that if your baby or if your grandchild used to sleep and doesn't sleep anymore, that means that the trajectory went down. That the sleep need did decrease, and it is useful to know that and to know what the average is and just default to that. In my book, I have all the charts, and I also have an app that I recommend. It has all these schedules, so you just put in your grandchild's age, and if it's a young baby, the weight is also important. Then it basically gives you the right schedule for any age group and also for when the parent wants to get up in the morning. That's when I said you can kind of shift that around. You don't have to just resign to getting up at 5am if you don't want to. If your baby is someone who needs more sleep than others, that's fine, but if they used to sleep and don't sleep anymore, then I would recommend looking at that schedule and just reducing the nap time to whatever the average is. Because thousands of babies sleep like this. Parents/grandparents are very worried about waking a sleeping baby, and I give you permission to do that. It's okay, and the baby will be fine, and they will sleep better at night because we have this total sleep need.

Dawn Brown: Does the time that you feed the baby impact or help

the circadian treatment as well and also what you're feeding the baby or toddler? Does that impact circadian treatment?

Dr. Axelrod: Yes, and yes. However, again, it's confusing because in the very beginning, the baby is so erratic, and you're also told (depending on the weight of your baby) [that] you have to feed on a certain schedule. Many pediatricians will make you feed the baby, for example, every two hours during the day, and you can't do anything about that because the baby just needs to grow. The main imperative of everything is just to regain birth weight and to establish a growth pattern, and so you can't and really impose any schedule on that, and you shouldn't. That's where, for example, the robust light/dark patterns are kind of the circadian entrainment you can offer the baby when the feeding and the sleep cannot. Later then, as soon as they regain their birth weight, then you let them sleep at night. That's when you start noticing [that] 'my baby starts falling asleep after this many hours, and that's when you can start kind of working towards a schedule. And the same with feeding. I think parents don't realize that after when they have regained their birth weight (and with a pediatrician's clearance) you don't have to stay on this extremely tight feeding schedule. I would ask your pediatrician how far should your baby be able to go without food and stick to that because if you end up nursing or feeding them more frequently than that, then that becomes something the baby just gets used to, just like the sleep. So yes, absolutely, feeding times can be used to entrain circadian rhythms, but I would figure out with the pediatrician for very young babies what that should be. For babies that have regained the birth weight typically, you can go three to four hours without feeding, so getting out of this constant feeding pattern that you know parents have with very young babies is very important.

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Dr. Axelrod: The other thing was about the food composition. That's super interesting for nursing mothers. It has been actually shown that the milk composition changes in the circadian fashion over the course of day and night, and that pertains to the nutrient composition of breast milk. It's a lot more fatty at night, and lactation consultants recommend, for example, if you pump to give the pumped milk at the same time when you pumped it because the theory goes that it helps the baby sleep better at night when they get the night milk because it's much fattier and also it is actually enhanced in hormones from the mom that help the baby sleep better at night. So yes, in terms of breast milk for sure. In terms of formula, no, because there's no variability in that.

Allison Thayer: I have one more question to wrap up. How broadly do pediatricians embrace your philosophy?

Dr. Axelrod: I honestly think that's why I even got into this whole thing because a baby's sleep is not a medical problem, right? A baby that doesn't sleep is kind of nobody's problem except for the overwhelmed parents. You go to your pediatrician, and as long as the baby grows, their job is done. That's really the only thing that matters for a young baby that they grow. They might throw you some advice, and of course, there are probably pediatricians who are much more into helping with that than others. Ultimately, there is really nobody there that will specifically help with a baby's sleep because it's just not a medical problem. It doesn't matter for babies' growth really whether they sleep during the day and then not at night. Whether they're sleep-depriving the parent or whether they're perfect sleepers and sleeping, that will not matter for their growth, and therefore, pediatricians don't necessarily have the training, or it's just also not in their wheelhouse really. So that's where someone like me who comes in to fill that gap. And yes, of course, I'm talking to pediatricians like my pediatrician and other people to get that word out there because I really think that when you become a mother, you just need to sleep. And again, who exactly will help you with that? It's not the pediatrician. It's not the GP [general practitioner] or the OB/GYN [obstetrics gynecologist], you're just kind of thrown into the deep end, and it's hard. I think this should become something that is more integrated into the healthcare system. I think that would be very important.

Allison Thayer: Do you know of any support groups, or have you been a part of anything that you've been able to talk to people more on like a mom level about this?

Dr. Axelrod: We have been very active in our own outreach. We have a Facebook group that is called "Science-Based Baby Sleep Support" again because there are just so many opinions out there, and I think it's important to talk about things in an emotional way because this is all very emotional, but always from the perspective of "what can we support with data" versus what is just more a philosophical question that nobody can really answer. There are all these trigger things: co-sleeping, sleep training, all these things people are very emotional about. We can discuss these things in an empathetic way but from the perspective of science.

Randy Reid: I think we're ready to wrap up now, and Dr. Axelrod, I want to thank you. I think your talk was just great, and I sure learned a lot, and I know our audience did as well. Allison, our producer, we want to thank you and the Light and Health Research Center from Mount Sinai for making this happen. And last, we want to thank our audience. We had great participation today, and we really do appreciate these questions.

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Disclosure: *Mr. Reid is Executive Director of the National Lighting Bureau, the editor of the EdisonReport and the editor of designing lighting (dl) magazine.*

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