How To Use Technology To Improve Sleep Transcript

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Introduction to Dr. Gartenberg

This is Dr. Talks, real talk from real doctors on the issues that matter to you most. Welcome again to the Sleep Deep Summit, new approaches to treating sleep apnea and insomnia.

I'm really thrilled to have Dr. Dan Gartenberg here with me now. Dr. Gartenberg is a sleep scientist with a PhD in cognitive psychology. He's currently the CEO of Sleep Space, And he's an adjunct professor at Penn State University in the Department of Bio behavioral health.

He's been developing sleep improvement technology for the past 15 years and has also worked for artificial intelligence groups in the Navy and the Air Force.

Dr. Gartenberg is the principal investigator for more than $3.5 million of grant awards from the National Science Foundation and the National Institute of Aging.

The goal of his important work is to help solve one of our most far-reaching healthcare problems, poor sleep health. Welcome Dr. Gartenberg. Thank you, Dr.

Wells. It is an absolute pleasure to be here. Fantastic. Pleasure to have you. And I want to jump right into a question that I have about technology and I'm sure other people are wondering as well.

So technology, electronics, screens, all of these things are kind of a mixed benefit and curse when we think about the last hundred years of human development.

I wonder if you can explain how you view technology as both a helper of sleep and a potential sleep hindrance. Yeah. So similar to nuclear technology, it can be used to power the world forever, or it can be used to destroy the world in a nuclear blaze.

So that's basically the way that I think about this problem of technology. Technology is just a tool. It's up to us humans to build it in the way that actually helps people and doesn't hurt people.

And as you, you know, elegantly said, I think for the past hundred years, well, technology has generally been good for society, but it has come at a major cost of sleep health.

I would say since it started with electricity really, which only became commonplace in the 1920s, which made shift work where everyone basically had electric light in their home and whatnot.

And this made things like shift work, staying out and partying, things that negatively impact the circadian rhythm, it basically made that possible.

Technologyu2019s Impact on Sleep

And there's a really good Gallup poll when we first started tracking sleep since in the fifties, showing that Americans have progressively slept less and less since the fifties going into 2010. It's about an hour less than we used to sleep.

And so I like to think about it as, you know, our circadian rhythm is getting disrupted by these technologies. And I think what's happened recently is The blue light from the devices combined, TV is one thing and there's blue light from that.

And one of my collaborators at Penn State, Dr. Anne-Marie Chang has done some of the pioneering work on how

blue light disrupts melatonin and prevents you from falling asleep.

But I think in the last 10 years, things have really accelerated in the bad direction. because of social media. Having the screen pinned up to your face, scrolling through Instagram in this weird dopamine cortisol experience has really hindered the sleep health, especially of younger kids, adolescents.

And this is why I think there's a really bad problem with depression and anxiety reports are showing for the younger population. It's a combination of the devices and poor sleep health.

So that's sort of the negative side of things. The positive side is if we use technology in the right way, oh, sorry, there's one more negative side and that's orthosomnia.

So a lot of times there's a new phrase in sleep science where your aura ring, your whoop tells you, you got a really bad sleep score. Maybe you're already anxious about your sleep.

You're naturally have a worrisome thinking style, something like this. And you see a bad score on your device and this makes you more anxious and you end up sleeping worse.

So I know, you know, about orthosomnia, it's a, it's a relatively new concept around two years ago when all these devices started, you know, really taking hold.

And it's sort of knowing how to interpret the data. And sometimes if a device tells you something. it leaves more questions than answers basically. So those are the hard things that we have to navigate when it comes to technology, but there is a way.

So, you know, we can make technology that does anything we want. And so I've tried to focus on a way of presenting the data in an understandable way, contextualizing the data for people, and then trying to make tech that really separates the phone, which I see as a really accurate sensor, but also tries to, you know, use the phone and other devices for sensing while putting the device in its place.

And so, you know, I have some technology that we can go into around that and using sound, light and temperature to enhance sleep during sleep. These are the positive things that technology can bring to the fold.

And it's up to us to understand how to use it in a way that's actually gonna help us. That's very well said. And like anything, there's a balance with how people are approaching technology, particularly at night.

I think in addition to the light stimulus, there's also that emotional stimulus from scrolling or interacting with social media that can compete with not only getting to sleep, but also staying asleep.

I wonder in your work, what are some of the limitations that you've seen with wearables and nearable devices, sort of tracking sleep or giving reports about sleep quality or quantity?

Yeah. So I know this intimately. I've studied in a lab, Oura Ring, Apple Watch, Spectrum Pro, which is a more clinical device. There's more. Some of them have, you know, fallen by the wayside, like sense AI.

And we will study them alongside Poway's somnography. So, you know, hooking people up to the electrodes. And I've built open source models based on these data sets for predicting sleep.

And we just published a paper in the journal, Sleep Health, where we're actually making our algorithm available two clinicians, two researchers, so they can actually understand the error for the devices because that's a major problem.

The billion dollar companies like Aura and Fitbit, they will not open up their algorithm because they see a lot of value in their algorithm. we decided to build, I think, the most accurate algorithm from wearables and then open up our sleep-wake detection algorithm so clinicians and researchers can actually use it in a way where they can

evaluate if there's an error or not in the data and the margin of error.

Something that happened a while ago is Fitbit randomly changed their algorithm and then everyone just started getting like a half hour more of sleep or something like that.

And that's an issue with black boxing it. You can't do like post-mortem on the data to see, you know, how it shifts or recently changed their algorithm too.

And so when I'm looking at the data. And so many people ask me, my aura ring says this, you know, sleep space says that. What does it mean? You know, it says I'm only getting a half an hour of deep sleep.

This is where the orthosomnia thing comes in. And I have to say to them, think about the data in more relative terms than absolute value terms.

Wearables, Accuracy, and Orthosomnia

So, you know, building these algorithms, I know how accurate and inaccurate they are. If you're familiar with signal detection theory, which is a little bit more nerdy, but you can think of it as like a measure of accuracy from zero to one.

Sleep wake, the area under the curve, which is like the sort of how we think about accuracy for a wearable. is 0.95. That's my current algorithm. For light sleep, it's 0.77. For deep sleep, it's like 0.8. And for ram, it's like 0.85, something like that.

So the higher the number, the more accurate the signal is reporting. Yeah. So basically like it's really good for sleep wake when we have a heart rate and motion sensor on the wrist or finger.

Another part of this is The algorithms are made for healthy white people. That's another aspect of this as well. And actually there's a lawsuit right now going on against Apple because their sensor's a little bit racist.

Because there's a pigment issue with the wrist actually. And detecting the oxygen level. Yeah, for the pulse oxygenation. The photoplasmography is what they use, PPG.

And the green light doesn't distinguish certain skins as well. And also keep in mind that a lot of these algorithms are made for healthy populations. So like, or algorithm used to fall apart for like super healthy people that had a really low heart rate.

It would say you got like three hours of deep sleep, which is essentially not possible unless you're like a developing mind, like a child, like it's really hard for an adult to get three hours of deep sleep.

So, you know, that's another thing. It's the populations. That's why the ring form factor is better. Cause it doesn't have that pigment issue for hands are basically the same pigment generally, no matter what your obesity is.

So the, the form factor of the finger is just a little bit better for a couple of reasons. So as you can see, it's a complicated discussion. The other part of it is if you have an issue like insomnia, there's a couple of things with that.

There's one thing if you're optimizing your sleep, there's another thing if you have maybe sleep apnea, if you think you might have sleep apnea and we can go into that.

Speaking about insomnia for a second, time in bed is really an important measure if you're doing something like trying to use cognitive behavioral therapy for insomnia, which is the recommended treatment for insomnia.

A lot of times you'll try to do stimulus control where you associate the bed with sleeping. The wrist doesn't know if you're in bed or not. You know, that sensor doesn't know.

So that's why I also like combining a bed sensor. And I have a way of doing this with my tech with a wrist sensor. That's like the best possible bang for your buck.

But on top of that, your perception is actually the most important thing when it comes to insomnia. And as you, I'm sure you're aware of, there's sleep state misperception is a type of insomnia actually, where you think you're sleeping a lot worse than you are.

It's still insomnia. You're perceiving you're sleeping really poorly, but you're actually not sleeping that as bad as you think you are. And yet you still establish the psychological effects of feeling like you have insomnia, the daytime problems of concentration or mood.

All of those are still present for somebody who thinks that they are not sleeping. Exactly. So that's why your perception is almost, if you have insomnia, your perception is almost more important than anything that any wearable is ever going to tell you.

Yeah. And so that's why we, we have the consensus sleep diary as an important measure. So as you can see, it's sort of complicated. It matters. Your issue, it has, it requires that metacognition to know what your issue is.

And then obviously if you think you have like some kind of underlying thing like apnea, then you should use an FDA approved device that can be used to measure pulse oxygenation or to actually diagnose apnea, WESPR, there's a bunch of them now, Watchpad, as I'm sure you know, ChinOne now.

I like to use the Circle Plus one, it's not FDA approved yet, but it has some pretty good measures of pulse oxygenation, so. Absolutely. I want to highlight a few of these points that you made because what you're saying is so in line with my clinical experience of people who struggle with their sleep.

So orthosomnia is the anxiety around the interpretation of the data you're getting from your wearable devices, which are almost by definition at this point, flawed or limited, at least in terms of sleep staging, especially.

One of the things I love about the wearables, though, is they kind of elevate your sleep into your consciousness, which helps people to focus on that and maybe make some changes in order to improve the sleep?

What do you think about that in terms of looking at the overall picture one night to the next to the next to the next? Exactly, thank you for bringing out the, I was bashing them for a little while, but thank you for bringing out the, that's the positive aspect, right?

So when I tell people to, when I tell them to use the data, I'm usually suggesting that they use it in relativistic terms. So I think there's really good signal.

If my aura ring told me I got 40 minutes of deep sleep one night and then an hour and a half another night, there's some real signal there. And then they can use that relative truth to identify, oh, it was that alcohol.

And that's like one of the main things that people identify once they start using these trackers is how much alcohol really destroys deep sleep. Another one they might notice is, you know, THC can inhibit the REM is just like, for example.

So yeah, thanks for looking at the positives. You know, this is a little bit near and dear to my heart because I've been using Aura for a while and they changed their algorithm a little bit.

And what I noticed was that all of a sudden I was getting a lot less deep sleep and it kind of It left me feeling a little disappointed, actually, because I liked waking up and seeing that I was in a certain percentage of deep sleep the night before.

And as a sleep medicine physician, I can understand that that was just an artifact of how the deep sleep was measured. But as a human being, I still had that sort of adherence to performance.

And I think it's tough when you're looking at sleep as a performance measure because you're unconscious. You can't really affect that too well when you're actually sleeping.

Instead, your sleep must be supported with daytime activities, alcohol consumption for one. So I wonder if you can list some other factors that would affect the measurement of your sleep with a wearable device or a nearable device.

Yeah. So there's some weird things that you might not expect sometimes. And I remember you must be one of those people that's wrote, that's like pretty healthy with a low heart rate.

Cause that is really, or was very biased towards your type of person. And it's because it was a proxy for overall health in a way. Yes. So it almost made sense in a way that they had it that way.

They're basically saying you're a really healthy person. they were erroneously saying that that means you're getting more deep sleep. Interesting. On some nights, I would have a deep sleep report of two and a half to three hours, just like you said.

And I knew that wasn't possible at my age. So I was already kind of incorporating that as taking it with a grain of salt, if you will. But again, when it changed, I was a little disappointed.

Yeah. So back to that question. And that whole situation was really interesting. There's weird stuff, like I've seen, especially for the nearable sensor that we have, like cats jumping on the bed will create a big artifact.

Like I know one of my clients has like four cats basically. And you can see the cats, like it looks like she's sleeping horribly. but it's really the cats being nocturnal creatures and jumping on the bed at all times, which is something.

But that's also a relevant signal actually, because that's like, hey, listen, maybe we can try to do something to get the animals out of the bed. Also with measuring the bedrooms, the bedtime sensor, obviously the sleep partner plays a role too.

So factoring that in or out, and we have some ways of doing that by having a sensor on each side of the bed. That's another thing that can play a role.

What I've seen in the literature, there's I mean some counterintuitive thing or some interesting things that you might not realize that can improve your deep sleep.

Some of this comes from like mouse studies, but it's also been replicated in humans, which is actually learning new tasks in the day. will help you produce more deep sleep.

And this is actually one of the best things for reducing dementia and Alzheimer's related dementia and cognitive decline is learning a new skill, whether it's a language, you know, even meeting people.

Sleep Apnea Detection and Home Testing

One of the hacks that I have is if you exercise to try to take it outside, to try to take different routes, because you're encoding different information.

It's just like subtle things like that. Like when we're constantly learning, that gives our body a reason to have more deep sleep because deep sleep is how we process information, essentially.

Obviously exercise, sunlight, consistent bedtime, wake time. Things you ingest. You mentioned the alcohol. I'm thinking caffeine, how late in the day you eat, your medications.

Yes. Those are obviously big factors too. I personally have a pretty high tolerance right now. I'm pretty good at stopping at 2 PM with the caffeine. Also, caffeine can be your friend too, if you're trying to stay awake a little bit, if

you have a sleep problem.

There's benefits of caffeine, but obviously it can have a negative effect as well. One, a little hack is to cycle in decaf for one week out of the month, reduce the, your tolerance to it.

Um, so you're not having to constantly take more and more caffeine to like feel the effects. Basically. It's a subtle hack. And then obviously if you do have sleep apnea and it's very common, I don't know if you've been following my journey with diagnosing that I actually have a mild case of it myself.

I gained around 20 pounds over COVID. And the statistics are that by 2030, half of Americans will have sleep apnea due to, as you know, the obesity epidemic and also people getting older, you know, the muscles just get weaker when you get older.

So it's really common. And even if you have like four hypopneas per hour, like you should probably have less than that, you know, which is less than the diagnosis.

Five is usually the threshold. So. Trying to solve that problem is one of the first places to start. But yeah, curious if you have any other. I totally endorse what you're saying.

And I think when I talk to people about their experience with wearable devices, there are a few questions that come up as common. One question is, which one is the best?

Another question is, if I have a sleep disorder, will this pick it up. And the third is how do I improve things? We sort of touched on how to increase sleep and improve the deep sleep and REM.

I wonder if you can speak more about your favorite trackers, presumably the ones that are most accurate and easy to use. And then also how people who have a sleep diagnosis would sort of view the data from their tracker.

Yeah. And I've gone through this journey myself. I was originally, I just had like small contracts with these companies, like just to investigate like how well their device is.

And then I stumbled on the fact that I personally had a problem, which was sort of an interesting thing to discover. And so If you think you might have, when I try to get someone to rule out a breathing problem, I'll recommend that they try Wespr right now is my suggestion.

And it is two patches FDA approved to be used by a clinician. A clinician can use it to diagnose sleep apnea. It requires three days, which I like, and it's rechargeable.

Because I've had issues, for example, with myself, since I'm a mild case, one night I won't show. I'm not exactly sure what it is because I have like barely drinking stuff like this.

Maybe it's like my position. I'm not sure. Maybe it's like a stress thing for that night. So one night I'll show no signs. And then another night I will show signs, which was an interesting finding that I got from Westboro.

But so they have like a thing just for $79. You can get the device for a month. which gives you the information you need to then get diagnosed. And you can either, I think they can set you up with a doctor for $160 or you can likely, I think, bring the…

data to your doctor and they can diagnose you. I got the actual diagnosis from a medical doctor for, I guess, $250 total. Basically, if it says you have no problem, you could probably not go to the MD for the extra 160. So you can rule out the problem for 80 bucks, basically.

And so that's what I recommend for that problem right now. And then for continuous monitoring, like I don't necessarily want to wear two patches every night.

So I I'm, I'm liking this circle plus for the continuous monitoring. Cause the problem with aura and I haven't tried the new aura that has pulse oxygenation.

but I know that it's like averaging over like five minutes or something like this. Right. Right. Whereas the circle plus is measuring every second and shows a very high fidelity to simultaneous ABG gas measurements where the blood gas is sampled directly from the blood vessel and compared to the readout from the circle plus ring.

Oh, you know more about it than me. I didn't know those details actually. Um, so yeah, and Meyer Krieger works with them. He's like the father of sleep apnea.

So that's a pretty legit person on your team. So yeah, I've been liking them getting the one second resolution actually lets me make actionable things from it.

Do you know what the resolution of aura actually is? I know that's an average, but I don't know how it's, how it's actually computed. But that's the thing you need the granularity because you're looking at changes over like a very brief period of time.

And since it's always such a high value, typically, it's really oral say you have like a 94% average. but that could still be a problem if you're having these drops.

Definitely. Yes. And I think it's one of the limitations of these consumer grade products. I would be really hesitant actually to rule out any sleep diagnosis from a wearable simply because any home sleep test, especially a home sleep apnea test, does have a tendency to underestimate the number of airway obstructions, especially the airway obstructions that cause brief arousal or awakening from sleep.

And this could explain some of the variability you're seeing with your own testing. If you wake up a little bit, instead of drop your blood oxygen level, that device does not necessarily capture those events.

And so overall, the sleep apnea severity can become diluted. And I think true.

Future of Integrated Sleep Medicine

It's kind of the direction we're moving in to add EEG to home testing as a way to capture those arousals coming from a blocked airway. I think that's going to be a phenomenal revolution in home testing.

I wonder what else you can talk about that is kind of the future of sleep technology and how we're going to move in that direction. Yeah, sure. And actually to your point, Apple just released a patent with their Apple earbuds to include an EEG in them.

Oh, that's fantastic. And yeah, just to go back to the, this is not FDA approved or anything. So this is still consumer. I think he's, they're getting it, the pulse oxygenation FDA approved, but it's not there yet.

So I just want. This is still considered the consumer sort of thing, but this is the best consumer continuous monitor that I would say. Totally agree with everything that you said that you can't rule it out.

But if it does say a certain problem, you can get pointed in the right direction. Yeah, in a way, the home test devices are only useful if they're positive.

And if they're not showing anything, I like to say they're inconclusive. So in the presence of symptoms, a person should definitely seek medical care for that.

Yeah. Okay. So the future. So this is what I, and I think you can, get behind, you'll be excited about this future vision too. So beyond my vision of the ideal sounds, light, temperature environment to promote deeper sleep.

And I've basically nailed sound and light. I want to do more temperature stuff. You know, there's like eight sleep

and there's a pillow for this now, Muna, that actually isn't publicly available yet.

But there's definitely a theoretically ideal sleep environment that will make everyone sleep more deeply. At MiTech, we adjust a sound machine such that we more effectively block out noise pollution with the speakers of the phone.

But beyond this, for sleep medicine, I really think the future is when the different branches of this diverse field start actually talking to each other.

Integration, yes. So it's crazy how like the AASM and then the association of dentists with the, you know, there's different solutions for this problem.

There's CPAP, which is the recommended solution for, let's just talk about apnea for a second. So the recommended solution for CPAP, as you know, is for apnea, obstructive sleep apnea is CPAP.

If you're non-compliant, which around 50% of people are, or a mild to moderate case, the dentist can make a mandibular advancement device that also has efficacy.

You can also combine these two. They're not necessarily mutually exclusive to one another. And there's some studies showing that when you combine them, it's even better.

the dentist and the pulmonologist are like, don't really work together. You rarely see that happening. And there's like, you know, the dentist can take business from the pulmonologist.

There's like that thought and vice versa. And then the other part of this, and there's a really good randomized clinical trial showing that people with comissa which is about 40, so sorry, COMISA is comorbid obstructive sleep apnea and insomnia.

And it's actually very common. About 40% of people that have OSA also have insomnia, partly because they're like, insomnia is about having a high arousability.

And if you're not breathing throughout the night, you're gonna be more readily arousable. So, There's a recent randomized clinical trial showing that by treating people with cognitive behavioral therapy for insomnia who have comissa, you actually reduce the hypopnea, the issues with the breathing, which is interesting.

It is. I mean, I think these two conditions interact negatively with each other in a way that we don't quite understand yet. And being that they are the two most common sleep medicine diagnoses, that's one of the reasons why they're paired for this summit.

So that people can understand that within one individual, both conditions may be coexisting and interacting negatively. Thank you for mentioning that.

So that's why I'm trying to make a new, this is like, I'm working on this right now. This is cutting edge stuff, but we're trying to validate a new treatment for comisa that actually brings together all of these effective modalities within some kind of artificial intelligence, digital based cognitive behavioral therapy.

And that's sort of the future that I see. I would love Dr. Wells, if you could maybe be a part of this too, if I get this next batch of grants, it would be great to work with you on some of this stuff too.

But I imagine that when you go to your doctor, when you go to your dentist, there's some kind of way to sort of phenotype which solutions would work best for your issues.

And you would get a treatment that's tailored to you for a precision medicine sort of solution. I love that idea and it's something that I'm trying to create because I think behind the doors of traditional medicine, like traditional healthcare and the healthcare delivery system, it's really hard to implement that.

So people are not seeing their physician frequently enough and even then only for 20 or 30 minutes at a time, which doesn't allow for that personalization component or even the education necessary to sort of cultivate that for yourself.

I wonder if you can talk more about the ways that sleep space has taken on to help people understand their sleep, understand what may be an issue that needs to be tracked or brought to medical attention.

Yes, thank you for bringing that up. And anyone can try it out for free for 30 days with this code that I think that I'm going to make available on this.

So we developed a cognitive behavioral therapy based solution. that integrates, that augments typical therapy. So we ran a randomized clinical trial, not to replace the cognitive behavioral therapists, these are usually psychologists, but to augment their practice.

So there's been other solutions in the past that have been FDA approved, they're called digital therapeutics. And an example was, another one was Sleepio.

And so they're designed to sort of replace the clinician That's not our approach. We're trying to augment the clinician with new tools that makes them more effective.

So we're showing that compared to a sleep hygiene control and treatment as usual, that when that therapist uses our internet of things solution, where there's meditations, there's lights that turn red and then ramp up at the bedtime that the clinician suggests, bedtime and wake time, it'll ramp up at the wake time for a smart wake experience.

We have this thing called a sleep journey where it has ocean waves that goes into a sound machine that goes into like 528 Hertz and affirmations in the morning.

And then every day they get a new task that's part of their six weeks of cognitive behavioral therapy for insomnia. And we just completed the last participant a couple of weeks ago and we're going to unblind the data literally in like a week or two to see if we're actually the most effective treatment for insomnia when a clinician uses our system compared to when they do their typical treatment.

That sounds really exciting. Hopefully it works. I've used the app. I've been on a sleep journey and I want to say that it's really enlightening because you get information that is evidence-based and really solid, high-quality information.

I've noticed that the sound component of the Sleep Spaced app is something that helps to sleep. And I've also had occasions when I'm waking up in the middle of the night, sort of toward the front of the night and I noticed different pulses in that sound.

Is that a feature of the app? Yeah. So we do this thing called deep sleep stimulation and it works better if you have the smart bed. So we have like a phone charger that detects micro motions and it turns off the sound.

If you start to wake up, you're it's actually supposed to be underneath consciousness. So like you shouldn't be conscious of the sound, but what got me interested in this is basically, and we have a peer reviewed paper showing that this is possible in a laboratory environment.

that if you pulsate sounds at the Delta wave frequency at the right time during sleep, it can prime these regenerative brain waves. Oh, that sounds great to me.

Anything that says regenerative brain waves sounds like a plus. Yeah, so it's easier said than done. So you probably shouldn't have been perceptually aware of it.

That actually means that hopefully it didn't cause any problems, but we try to do it at the level where you're not

going to be perceptually aware of it.

Sleep Space Tools and Targeted Memory Reactivation

And then if we have, if you're using an Apple watch or our sleep space smart bed, or you can place the phone on the bed at the foot of the bed, which is sort of a bad sleep hygiene thing.

But you know, if you put it, if you have like a big bed and not a sleep partner, it could make sense. Then we're more accurate at delivering the deep sleep stimulation sound.

And that's why getting the phone in the same place every night was very important for me because I want to play the sounds very precisely. Because the issue is if you play a sound too loud, it easily wakes the person up.

So that's sort of the tightrope walk is how do you play the sound so that the brain responds to it, but it doesn't push them into an arousal. Got it. Got it.

I think one of the limitations in my case was that I wasn't using your smart bed feature and my phone is on the bedside table. Yeah, it doesn't work as well.

Yes. I still thought it was interesting. Sort of preparing for this interview today. I also wanted to be sure and ask you about targeted memory reactivation.

Can you explain what that is? Yes, that is also the future that I'm working on. So that's another line of research that I'm, I'm, I'm exploring. And there's some classic papers around targeted memory reactivation which you can Google and see all the science on there.

It's not necessarily my thing that I that I've discovered but I sort of added to it in a way. And the classic study was that people would do a cognitive task, like a memory task or something like this, while they smell the scent of roses.

And then during, actually there's a meta-analysis recently showing that during N2 sleep, it's most effective. If you reintroduce the smell of the roses, that you created this association between the task and the smell during the day, that it primes that association.

So those individuals do better on that task the next day. It's basically a fancy scientific term for inception. If you're familiar with that, that movie with Leonardo DiCaprio.

So, so I have this whole method of, you can focus on a meditation, play a sound while you're doing the meditation, like rain sounds. And then you'll try to build that association and then we'll replay the rain sounds when you're in different stages of sleep.

and try to get you to prime that association. And I think it can be useful for nightmares, you know, things with memory. There's a couple of, even like trying to like actualize your ideal self, like folk, like it's like a better way to sort of meditate and get into the right mind space.

Cause it's augmenting the meditation with integrating that in your dreams is the idea. That's so fascinating. And my mind is kind of going crazy with potential applications.

I'm also impressed with how much of a sensory experience sleep is. Light primarily drives sleep and wake. Temperature can signal sleep or wake. Sound, smell, and this really kind of brings us back to our roots as human beings, how we really have to honor that, honor sleep as a biological need.

And it's fascinating to hear how we can apply technology in order to accentuate that, augment it all in a way that doesn't involve pills. Exactly. Yeah.

That's the vision is non-pharmacological, multi-sensory solutions. And it's just easier said than done. I mean, the

stuff with the sound is pretty complicated.

If you wanted to go into temperature, it's complicated. Even the limbs. Like how you respond to how your limbs respond to a temperature is different than how like your core might respond to a temperature.

So there's a way of doing it. It's just a complicated science of doing it the right way. Well, I so appreciate that you're working on this to sort of distill out the important factors.

Um, as we wrap up here, Dr. Gartenberg, I wonder if you can tell me how people who are watching this can find you. Yeah. So my tech is at sleepspace.com.

And anyone can try it for free for 30 days. You know, if it works for you, then, then after 30 days, maybe you can pay the small subscription fee. And so they go to sleepspace.com slash union, and you can cancel anytime before that and you won't be charged any.

at any point, you won't be charged at all. So that's sleepspace.com slash union. Union. Got it. And I certainly appreciate your time today. Thank you so much for talking to me and bringing your expertise to the discussion about sleep and technology.

Thank you so much. Appreciate it. Take good care. Bye-bye. Thank you for tuning in to Doctor Talks. We hope today's episode has enlightened and inspired you on your path to optimal health.

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