Dr Andrew Huberman

PROTOCOLS



An Operating Manual for the Human Body

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ANDREW HUBERMAN
with JESSICA WAPNER

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For Costello, Zoë, and Strummer, whose only tasks were to sleep well and enough, eat clean but not too much, stay hydrated, view sunlight, and get exercise. And endlessly give and receive love. Must be nice . . .

For everyone else: I wrote this book for you.

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Introduction

Welcome to *Protocols*.

This book is a guide for improving your health and performance. If you're struggling with one or more areas of your health, it can help you. If you're generally feeling good and you want to level up one or more of those areas, it can also help you.

What is a protocol? A protocol is an established formula to help you overcome common obstacles, achieve a specific health or performance goal, or generally improve your day-to-day physical or mental state. Each is simple to implement. Each is designed to take the minimum amount of time to produce the greatest possible results. Each can work the first time, and every time.

As you learn these protocols, you'll discover the science behind why they work and, in doing so, you'll also discover a lot about how your brain and body work. Because each is based on known aspects of our physiology. They work because they are based in how we work. The science is important for at least two reasons that go beyond just substantiation. First, by understanding how a given protocol can, say, improve your sleep or your ability to focus and

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learn new things, you place yourself in the position to customize it to suit your needs, while still allowing it to produce the effect you want. Second, you'll start to see similar biological themes turning up in what otherwise would seem like disparate systems. Our brains and bodies repurpose a lot of the same mechanisms to allow these systems to work in concert. Knowing some of the science behind each protocol affords you insights not just into how that protocol works, but how different protocols synergize. Practically speaking, that gives you a level of control over your health that simply learning "do protocol A to get effect B" just can't provide. You can determine what works for your needs and your goals in the context of your life, without having to make the pursuit of health a singular focus.

Because let's face it: The real reason to do any of these protocols is to feel and perform better, mentally and physically, and to have more energy so you can go about the rest of your life.

I should say, too, what this book is not. This book is not about "optimization," at least not in the typical sense. That word calls to mind the idea of spending a lot of time perfecting your daily routine. True optimization is about rescuing time—not just by increasing the number of years of your life, but by increasing the number of effective hours of your days (and the number of hours of great sleep at night). Many protocols in this book take only a few minutes to do and can be done whenever you'd like. Others take a bit more time or need to be done within a certain time frame each day or week.

You'll also notice from just these few short paragraphs that I eschew the whole notion of "biohacking." A hack is a shortcut that involves leveraging something toward a typically unrelated goal, like jury-rigging a paperclip and tape to fix broken eyeglasses. Hacks are never long-term solutions. The protocols in this book are the opposite of hacks. They are science-supported tools, grounded in robust physiological mechanisms—neural circuits, hormones, and neurotransmitters that have been hardwired into your brain and body

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starting from even before you were born. You just need to learn how to access them.

You'll notice that I mostly emphasize the behaviors that can make the greatest difference in your immediate and long-term health. However, because I often get asked which prescription drugs, supplements, and devices are useful to help achieve a given health or performance goal, I discuss those tools too.

Indeed, "What should I take?" is one of the most common questions I get from both men and women. Many people have a perception that the secret to health and performance resides in exogenous molecules—meaning something that comes from outside our body. Make no mistake: Certain pills, powders, or injectables can make a positive difference in health and performance. But because certain behaviors can so potently activate multiple physiological mechanisms, including the release of endogenous molecules—meaning, you guessed it, something that comes from inside our bodies—there is simply no replacement for them. That is why no pill can (or ever will) replace exercise, or sleep, or proper stress control. Even drugs that allow for neuroplasticity, or your brain's capacity to rewire and learn, won't produce learning on their own. Plasticity must be directed toward a particular endpoint. That requires certain behaviors. We must do the right things in the right sequence. Or, as a colleague of mine aptly put it, "better living through chemistry still requires better living."

Which means you don't have to buy anything to achieve your health or performance goals. Some people have disposable income to devote to tools for health and performance. Others do not. I wrote this book for everyone and can assure you that it is (and I believe always will be) a core fact that behavioral tools really move the needle in the right direction. And the right ones can work for everyone. Whether you are young or old, currently fit or out of shape, the protocols in this book can make you feel, look, and think far better,

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and thereby show up better at work or school or on the field or in the gym, and in your relationships . . . even in your relationship to yourself. I know that statement to be true because literally millions of people have implemented these protocols to great success and continue to do so every day. I also know because I personally use them.

In fact, I discovered many of the protocols in this book because I needed them, in some cases urgently. I, like so many others, have struggled with sleep and stress, finding the "right" diet, knowing the best way to exercise to meet specific goals, and on and on.

But if I have one innate quality, it's curiosity. I love to learn. I also love to share what I learn with others. And what drives my curiosity—at least in the realm of health and performance—is the same thing that likely brought you to this book: I wanted to know the best solutions to those challenges.

There are no tools included in this book that I have not personally tried. Some I have used for brief periods because they are for overcoming a sticking point, and then best set aside. Others are mainstays in my daily life and will remain so until I die because they are so central to my physical and mental health, and my ability to focus and learn effectively as they continue to help me reach my performance goals. I stand by every tool and every concept.

These protocols cover what I know works. Whereas on the *Huberman Lab*, my podcast, I explore and share both topics of which I am certain as well as topics that I'm still exploring—such as peptides or psychedelics—this book focuses mostly on the former. Its chapters on sleep; exercise; stress control; nutrition; light; focus, motivation, and learning; and personal growth are the result of years of research, both in the lab and in life, from experts in every topic, and from my own work. Some protocols are basic; others are more advanced. You'll be able to decide which are best for your needs and goals.

For those of you who are new to my work, I'll share a bit about my background for context and how we—yes, me and you—got here. If you're going to read this book and use these tools, my hope is that you'll come to see that

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we are collaborators on this journey. Again, I discovered many of the protocols in this book because I need them. If you do too, know that you are not alone.

As of writing this introduction, I'm fifty years old. For the last three decades, I have spent most of my waking hours researching how the nervous system—that is, the brain and the spinal cord—works, develops, and can change, for better or worse. This is referred to as neuroscience. I first learned about the field of neuroscience in college, from Harry Carlisle. He was a physiologist, a neuroscientist, and a professor at my university. I took his course, and there I first learned about brain circuits for motivation, about learning and memory, and on and on. This treasure trove of knowledge simply did not exist anywhere else at that time, not even in textbooks. He taught all of neuroscience but emphasized the neural and hormonal and peptide interactions between the brain and the body. Harry knew how to connect the dots in a way that only a masterful teacher can. During a lecture one day, he paused writing on the chalkboard, turned to face us, and said: "The next time you see someone delusional from schizophrenia, or collapsed from depression, or addicted to speed, consider what it is to try to move, think, or feel a certain way when the neurons—the cells that subserve those efforts—are simply not there, or are broken . . ." Something clicked for me.

In some sense, I was primed for that moment. By nineteen, I had witnessed a lot of people with mental and physical health issues related to the brain. Several had become badly addicted to alcohol and drugs. We now know addiction is a brain issue, but back then, most people thought it was simply a lack-of-willpower issue. Many of the "high functioning" people I grew up around suffered from anxiety or depression. By humanizing science and explaining that what often appears psychological is actually physiological, Harry's course inspired me to become a neuroscientist. Also, what could be more interesting than the brain?

To be fair, becoming a scientist wasn't entirely unexpected. I've always

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loved observing and learning about animals, including humans. And my father is a scientist—a theoretical physicist. Until I was thirteen, my family ate dinner together every night, and my father's colleagues would sometimes join us. While other families talked about politics or discussed sports over dinner, the only "sport" in my home was science, and the star players were scientists. I heard stories about Richard Feynman and Murray Gell-Mann, famed Nobel Prize–winning physicists, and Ed Wilson, the founder of sociobiology, along with other luminaries. We still laugh about the time when my sister, then a toddler, walked over to one of the most famous Nobel Prize winners, smiled at him, and then threw up on his lap . . . and he was cool about it. And my maternal grandfather was a biochemist. When we visited, he would take me to his lab to help collect data on the metabolism and body composition of rats fed different types of diets.

So it made perfect sense that I would become a scientist, right? Well, yes and no. When I turned fourteen my parents divorced. I harbor no resentment about it, but at the time, the change made things at home and school unravel. Keep in mind, it was the 1980s, when divorce was less common, and I hit puberty at fourteen too, so it's impossible to know if what ensued was fueled by the sudden disruption in my family structure or the surge of hormones in my brain and body. As we say in science: "Bad experiment . . . too many variables to determine causality."

What I do know is that from ages fourteen to nineteen, before I found myself in Harry's course, my life was a blur of wild, eye-opening adventures, painful losses, and at times, full-blown mayhem. I got really into skateboarding—which back then was rather niche. I loved skateboarding for the activity itself, and for the community of eccentric and often unruly characters it attracted. And I loved that it was a daily lesson in discipline, focus, and energy: You try, try, try, fail, fail, fail, almost succeed, then fail one hundred times more before you finally land the trick. Often with plenty of pain all along the way. And skateboarding was 100 percent self-directed. We all

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pushed each other by example, and encouraged each other too, but there were no coaches, no referees. Indeed, skateboarding was a go-to activity for those of us who wanted to do a sport but for whom parental involvement wasn't necessary or, frankly, wanted. We were completely feral. And "we" were multi-generational and from every background imaginable. Skateboarding has also always been an unusual sport because it has twelve-, thirteen-, and fourteen-year-old kids hanging out with guys (back then it was almost exclusively guys) in their late teens, twenties, and thirties. Some were from the suburbs. Others from cities. And they came from all over the country to the legendary spots we frequented. I became close friends with people from all walks of life. And I got a lot of exposure to drugs, alcohol, sex, and violence. I also missed a lot of school.

I was okay at skateboarding. I picked up a small sponsorship or two. But I was never a contender to turn professional. As much as I may have wanted it and worked at it, I just didn't have the chops. I am blessed to know and remain friends with several of the greats from that time. And I witnessed some truly historic skateboarding. It's impossible to put into words the amount of raw energy and innovation you would find at the now-legendary Embarcadero Plaza ("EMB") in San Francisco or at a contest in San Diego, or in Washington Square Park in New York City in the early 1990s. For that and many other reasons, those years remain among the fondest and most inspiring memories of my childhood. But that's what I was: a child. Marbled into all the amazing experiences were a lot of hard ones too. Now, I want to be careful with what I say next. On the one hand I wouldn't wish a lot of what I experienced in those years on anyone, much less a young kid, but I also wouldn't trade it in either. I was completely free, and yet I felt uncertainty about everything. I got hurt a lot and spent a lot of time on crutches.

My physical injuries led to a few very good decisions, however. They motivated me to go against the convention among skateboarders back then and start running and training with weights. While it might seem commonplace

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now, in the early 1990s, unless you were a bodybuilder, pre-season football player, or headed to the military, no one lifted weights. Gyms were not a thing. Even weirder was if you were an American kid who meditated, but I started doing that too.

That taught me the basics of exercise- and stress-induced adaptations, and how they are similar and yet different. It goes something like this: Run farther or faster than the last time and the next run becomes easier . . . and unlocks the opportunity to run a little farther and faster, and so on. Lift a weight until you can't do another repetition despite your best effort in one session, and the next session, you can lift the same amount of weight for more repetitions, or move more weight. Set a timer for five minutes, sit still and try to focus on your breathing while the inevitable agitation grows, then subsides, then grows again. The next day, set the timer for six minutes, then seven minutes; and pretty soon twenty minutes is doable.

Another very good decision, though not exactly related to the physical injuries: I started thinking about college. My girlfriend had graduated high school a year ahead of me and moved away to university. I missed her and would visit often. In the end, I mostly applied to college just to be near her. I didn't really expect to get in. But I did.

As you might predict, my first year at college did not go well. I kept up with exercise and meditation, but I missed lectures, and I got into stupid fights. The adage "you get out what you put in" is true. I got what I deserved, which was not a whole lot.

Then came the big turning point. On the Fourth of July, 1994, when a group of us were arriving at a barbecue at our friend's house and saw it was getting robbed, we did what any young male morons would do: We fought the robbers. I don't remember it even being a decision. I just recall running straight into the mix. Anyone who has actually been in a street fight—not a boxing class, or a sanctioned match with gloves and a referee—will tell you that it's not like in the movies. Things can escalate really fast, and people can

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get hurt, or killed. That fight was ugly. Although luckily no one got badly injured, the police showed up and we all had a lot of explaining to do. The guys who were robbing the house were arrested, not us. In fact, before driving off, the police congratulated me. I felt nauseous. It wasn't that I wished I had gotten in trouble for what had happened; I just realized that I was going nowhere in life, so the accolades felt more like a loser trophy than anything worth celebrating. Somewhere in my gut I knew that regardless of who was at fault, I wasn't making good choices; I knew I was gravitating toward self-destruction.

I spent the rest of that July Fourth weekend in reflection. I was nineteen, and I wasn't good at anything useful. And I wanted to be. So I made the decision to get my life on track by focusing on something I knew had an "if you just show up every day and work hard at it, there is something waiting for you at the end" quality.

I decided to focus on school. I didn't know what I would do with a college degree or even what degree to pursue, but at that point I didn't care. I just needed a path I knew would lead to someplace better than where I was at that moment. I would figure out the ultimate goal later.

Having missed so much of high school, I knew I was coming from behind, so I moved to a studio apartment away from campus. I studied around the clock, stopping only to go to class, eat, sleep, or exercise. To say I was motivated is an understatement—I lived in the constant fear of remaining a directionless loser, and that kept me going. I didn't have solid study habits from high school to rely on. So I brute-forced it. I would set a timer and push myself to study in two-hour blocks, refusing to let myself get up even for a trip to the bathroom. After each block, I would take a short break and then get back to work. After I completed three of those cycles, I would allow myself a nap if I needed it, then I would hammer out three more. I worked alone, in my studio apartment, reading and taking detailed notes on every chapter, passage, and sentence. I drank ungodly amounts of water, yerba maté, black coffee, and Diet Coke with lemon juice. I went to every lecture and office hours. I tested

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myself on course material in my head while I biked to class and when I lay down to sleep at night. My first and last thoughts of the day were about my course material. I sat in the front row of every lecture. Mind you, I still had no idea what I would declare as my major. No specific subject felt like "the one." I was just clawing my way forward. My girlfriend—who had known me since high school—remarked, "What happened to you?!" She was at once pleased and a bit frustrated with my turnaround. On the one hand, now I was more acceptable to her parents, but I was also a lot less "fun" to be around. Perhaps other guys could go out on Friday and hang out at the beach on Saturday and go to concerts in the park on Sunday and still do well in school. I was not one of them. I was on a mission to right myself. Once a month or so I would go to a party. Friends jokingly called me "Dart" because I would "Irish goodbye" at midnight, to ensure I got enough sleep so I wouldn't blow the next day. I didn't feel I was missing out on anything. By nineteen I had accrued enough wild experiences and parties for several lifetimes. For me, the action was elsewhere.

But soon stress and lack of sleep caught up with me. Also, while fear is a potent motivator, it's not a sustainable one. I started catching colds. I got into a bike accident. Back then no one really talked about stress or the importance of sleep the way they do now, much less why it's important to cycle periods of focused intensity with rest in between in order to avoid burnout. I bumped up my meditation from twenty to thirty minutes a day. That helped reduce my stress and improved my ability to focus for long stretches of studying. I kept up my exercise program of lifting and running three times a week each, but I started approaching my lifting sessions and runs also as forms of meditation.

Something unexpected but really cool happened with that. I found that by putting as much attention as possible on each repetition in the gym, or by letting my mind go blank while I ran, I soon could switch on those brain states of focus and calm when not exercising. It was my first taste of learning how to

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deliberately access, and shift between, different brain states. I was intrigued. So I started reading about brain states. Which led me to reading about drugs. I was never much into recreational drugs. In high school and college, I drank alcohol and I smoked a bit of weed, and I tried psilocybin and LSD. I confess I didn't like any of it. Caffeine was my drug. I mentioned that to the owner of a Chinese medicine shop in town. She encouraged me to try a few herbs instead of coffee. One made me feel like I was going to have a heart attack (pure ephedra tea? I do not recommend!) but a few others made me both incredibly focused and calm for hours at a time. Cool! . . . but then they quickly stopped working. Not cool. I also tried a mineral that an acupuncturist said would give me much deeper sleep. It gave me lucid dreams, which led me to read a book by a guy named J. Allan Hobson at Harvard about the neurochemistry of sleep and dreaming. That started me on limiting my caffeine at night. But those experiments worked: I began feeling better and performing better in my classes again. I was excited by the idea of how significant shifts in my health and performance could come about from seemingly small behaviors and, in some cases, from ingesting specific compounds.

I also experimented with over-the-counter supplements. A few really worked: For instance, I started taking creatine monohydrate when I was twenty, and it definitely helped to make me stronger. Only now do we know of some of its additional benefits for cognition, especially when mildly sleep-deprived.[1] I tried ginseng and ginkgo but they gave me brutal headaches.

The sum total from all I was doing was that not only did my level of focus and performance in school improve tremendously but my mood improved too. I was sleeping well. I consistently woke up excited for the day. I kept building physical strength. Every Sunday I would go on a long run lasting an hour or more. I had gained a level of control over my life. Studying new information for hours at a time had become a habit, and even an enjoyable one. I had come to associate the frustration of not understanding something at the start of a learning session as a stage to get through, not something to

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avoid. I never expected to land a skateboarding trick the first time, so why would learning new information be any different? I knew the formula: reps, reps, and more reps until you get it. I was starting to understand the learning process as just that, a process.

And right then is when I found myself in Harry's course in neuroscience. That's when things clicked. I was finally able to bring all the resources of discipline, focus, and energy to a specific, career-related goal: I would become a neuroscientist.

To this day when people ask me how to find their calling, I say whatever you do, don't wait for it to find you. Start working hard now and learn how to take care of your mental and physical health while doing it. It could be school, or a creative pursuit, or starting a business, but stick to that structure. Do *something* hard (for you) that builds on itself every single day. It will ready you for when *the thing* becomes clear.

I've seen so many people work at something like crazy, ignore their physical and mental health, and burn out. Or wait for their calling to beckon them, and have their physical and mental health spiral in the meantime. The key is to make sure the things you do to support your health also prepare you for your calling when it comes. Build mental and physical strength and resilience. And endurance. Master getting a great night's sleep on a regular basis. Work hard in whatever job you do. That's the secret.

I worked hard in Harry's lab during my junior and senior years of college. We ran experiments side by side. I devoured every book I could on the topic of the brain, and physiology too. I went to neuroscience seminars with the grad students and professors. Harry and I even published a paper together. It wasn't a landmark study or anything, but it was solid. And I was the first author on the author line. Which meant I wasn't just another undergrad who volunteered in a lab to get a letter of recommendation for grad school. I was a real scientist. A nascent one, but a scientist nonetheless. "Anyone can read and critique a paper," Harry said, "but once you go through the process of

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posing a good question, wagering a hypothesis, designing and carrying out experiments, analyzing the data and writing up the findings and your interpretation of them, and you get it peer reviewed and published, you're forever changed. You'll never look at data—or the world—the same way again." I am forever grateful to Harry for giving me that opportunity.

And indeed, I applied everything I learned about the process of doing that study to my pursuit of tools for health and performance: reading, learning, asking questions, testing hypotheses, and gathering data about how different types of exercise, light, nutrition, and so on affected me. I found much of this information shrouded in esoteric names or siloed into subcultures in ways that made it difficult to access. But I had been part of a subculture once before, and I had learned how to navigate it. And because I had grown up among scientists, I knew that this information could be useful to many.

Indeed, I would occasionally spot an intriguing overlap between something I had learned in my biology textbooks and what I happened to stumble upon in my pursuit of tools for health and performance. My once disparate worlds were starting to gradually converge.

And while my life after college may read a bit dry, like a CV, for me it was incredibly exciting. I became obsessed with our biological rhythms, and how they were affected by light. I got my master's degree by mapping the eye-to-brain circuits that help control those rhythms, and published those findings. From age twenty-five to thirty, I completed my PhD in neuroscience, researching the development and neuroplasticity of the brain. A lot of people hate grad school and finish looking a decade older than their biological age. I loved it. I worked for a scientist named Barbara Chapman, who taught me how to ask really good questions and design the right experiments to address them. She gave me a lot of leeway to develop new tools to answer previously hard-to-crack mysteries. I published six first-author papers with Barbara, all in terrific journals, including one in *Science*. None of it was easy. I routinely worked eighty-plus hours a week. It was both mentally and physically

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demanding. Turns out the skill I learned on road trips long ago—sleeping in cars and vans—served me well. So did all the tools for sleep and focus that I had figured out in college. Because I often slept in the lab. Along the way, I presented at dozens of meetings, an important part of academic training for which I am forever grateful. No one is born a good public speaker. It's a skill. One I got good at only because I had to present data to both friendly faces and expert critics who were anything but soft in their delivery. Nothing went perfectly, but little by little, and with plenty of red-in-the-face gaffes along the way, I was gaining mastery at my craft.

Professionally, it all paid off too. I got a great postdoctoral fellowship at Stanford. There I kept working with complete focus, day and night. I was inspired to do so, because at Stanford everyone was operating at the highest level. It is a truly amazing place.

But the postdoc step is an uncertain one in a scientist's career. There is no degree at the end, no promise of success even if you show up and work extremely hard. The vast majority of postdocs drop out of academic science and many out of science altogether. Also, my project had me competing with a big lab back east and an even bigger lab in Switzerland, and I was a lone postdoc chipping away with the help of two Stanford undergraduates, Nicko Josten and Mike Susman. I felt the pressure of not failing; I didn't want us to get "scooped"—nerd-speak for "beat to the punch"—on publishing. For the first time in a long time, fear and stress reentered the picture. And something else happened too. One day as I was headed into the lab, I found I barely had enough energy to climb two flights of stairs. And I slept fine the night before. I was doing everything "right." Or at least I thought so . . .

So I returned to the process that had served me well in college: I searched for tools on how to healthily increase my mental and physical vigor day in and day out. I read, I self-experimented. I also spoke to people who seemed to have a lot of mental and physical vigor but who came by it through effort and therefore understood the process, not simply because they were gifted with

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great genetics or were innately high energy. At that point I had no intention of being a public health educator. I just wanted to know what would really help me, a person very willing to put in effort but not a natural in any regard with respect to fitness, learning . . . or really anything.

Though I was, and remain, curious. The adage "seek and you shall find" is true. I found new ways to support my health and performance. Some things have remained the same over the years—for instance, I've hardly ever altered my overall exercise routine, as you'll see. It continues to work well, and not just for me. But other things caused me to make immediate changes to my diet and the way I approach sleep. I adopted a daily practice for something kind of like meditation but which is fundamentally different and quickly restores mental and physical vigor, even when sleep-deprived. And I found new tools for focus. I got good at task switching. All of it helped me complete my postdoctoral training at Stanford with first author papers, a host of invited reviews, and most importantly, the skills and confidence to take the next big step.

I was fortunate. I had made a name for myself in the fields of neural development and neural regeneration. Several figures from my papers were in major textbooks. I accepted a position as a professor at UC San Diego, one of the best neuroscience programs in the world. I was now teaching both undergraduate and graduate students in the classroom and in my lab, writing and reviewing research papers and grants for the National Institutes of Health, and traveling the world to give seminars. I was on journal editorial boards. My lab published a paper in *Nature*—arguably the best and most competitive journal in all of science. And many more in other top-tier journals. At forty, I returned to Stanford, this time as a tenured professor.

So all was fine and good, yes? Alas, no. While I was in grad school, Harry Carlisle—the person who inspired this path and with whom I had become close friends—took his own life. Soon after I started my lab in San Diego, Barbara Chapman died of breast cancer, at fifty. I was devastated.

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And then my former postdoc advisor at Stanford, Ben Barres, had a heart attack right in front of me at dinner. He was an MD, and a PhD too, so when he looked up from his salmon filet and said, "I'm having a heart attack," I didn't ask questions. I rushed him to the hospital, where later we learned it wasn't just a heart attack. Ben got diagnosed with pancreatic cancer. He died about a year later.

I was never prepared for this kind of news. And it seemed to be coming from all sides of my life past and present. In one particularly dark month, three close friends of mine from childhood—Aaron King (the famed graffiti artist ORFN whose work showed in the San Francisco Museum of Modern Art), John Eikleberry, and Jonny Farrer—all of whom were kind, creative, brilliant people, died. Stomach cancer, fentanyl overdose, suicide. I was devastated.

At a far less tragic but still concerning level, often when I ran into friends and colleagues I barely recognized them because they were so out of shape. And often in pain. They complained about their backs, or insomnia, or autoimmune issues. They were concerned, too, about the health—both physical and mental—of their kids. Mind you many of these folks were MDs or scientists. They knew the science but that didn't seem to matter. One colleague of mine in San Diego became addicted to pain meds and stopped running his lab. Then he died. No one in our community talked about it. It was as if we thought we were immune to the addictions that stem from the very brain circuits we studied.

It became clear to me that a lot of people were struggling in one or more areas of health, as I once had. It didn't matter if they were doctors, scientists, entrepreneurs, or musicians, male, female, young or old . . . no one was immune.

Of course, I didn't have all the answers. But I had tools I knew were potent and could be valuable to others. And from my research, both in my lab and outside of it, I understood several of the mechanisms behind why those tools worked. I was by no means an expert in all fields of biology, but I was fluent

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in neuroscience. By the time I was a professor, if I had any questions about a specific field of biology, I knew world-class experts who could give me the answers, if such answers existed. I knew a lot of world-class MDs too. And experts in physical health and performance.

Some of the best tools were little-known variations on the classic "eat right, get sleep, exercise" adage. These variations were rarely discussed but maximized results. Other tools came from experts in the trauma-healing and addiction-recovery communities. Some came from elite athletes or their coaches. Still more came from my most forward-thinking MD colleagues and friends. My benchmark was always the same: If the tools worked for me and for others, did not require a lot of time or money, and were safe, they became part of my arsenal, and I would pass them along to others if I thought they might be of help to them too.

Mind you, all along I was still working in my lab, studying brain development, regeneration, and neuroplasticity. Our work was increasingly focused on remedying diseases, but none of it was related to issues I or family members personally had challenges with. But because I saw that stress was such a pervasive issue, and at the heart of so many of the health and performance challenges that so many scientists and MDs, young and old, were struggling with, I decided to devote a significant fraction of my lab to studying stress, resilience to stress, and real-time stress control. My lab's work became more immediately applicable to more people. And that felt good. Here were more tools for friends, family, and colleagues, and they became part of my arsenal as well.

While I love academic science, it has always been somewhat painful to see incredible data from published findings that I know could be of benefit to the general public kept out of their reach. It's not that the scientific community actively hides their findings. To the contrary. Universities have press offices, and the news outlets have long had health and science sections. But all I had to do was compare what the press said about the work I knew and

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understood, with what the scientists who actually did the work said and what some of them were starting to do to support their own health and that of their families, to know that there was a gap—a trench, actually—between the two. No one was to blame. There was nothing nefarious going on. It was just how things were. I decided to try to fill that gap.

Which is why in 2019, I started sharing tools for health and the science behind them on social media, and in 2021, I started the *Huberman Lab* podcast. At that time much of the world was locked down. Stress was at an all-time high, so I felt even more compelled to share information I knew could help people. I knew nothing about podcasting, but I grew up with the ultimate example of DIY media: Skateboarders have always filmed their own movies, long before social media or reality TV made it a thing. My close friend from high school Jake Rosenberg filmed us all as kids. He eventually became a legend in skateboarding filmmaking, as well as one of the original contributors to the film editing program Adobe Premiere.

So to start a podcast, I DIY'd it. But not alone. I recruited my friend Rob Mohr, who had a small podcast and knew the basics of the genre. We looped in famed skateboard photographer Mike Blabac, skateboard filmmakers and editors Chris Ray and Martin Fobes, and we did what we knew would work. We recorded a person—me—talking about and living his passion: science and tools for health. I also started interviewing my colleagues from Stanford and beyond on the podcast. (My bulldog-mastiff Costello was asleep under the desk in my recording studio/closet snoring away for many of our first episodes.)

There are three other critical players who make it work. First is Ian Mackey, whom we (ethically) poached from Stanford's media team to come work for the podcast. Another is Greg Annunziata, who was my Uber driver and is now *Huberman Lab* podcast admin. It's not uncommon that people ask me questions about tools for health, but on a short ride to the airport one day, Greg asked the right questions. I immediately recognized that he was as

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curious as I am. As he dropped me off, I said: "You should come work for me." That was four years ago.

Everyone on the team wanted to learn, and apply, science-based tools for health and performance in their lives. Mike used the tools in this book to bring lifelong blood pressure issues into check and to lose, and keep off, sixty pounds of extra weight. He also quit excessive drinking, something he had done for decades. Ian—once very overweight—is now super fit and thriving in every aspect of life. Another member of the team has multiple sclerosis and, with these tools, has been able to reduce a lot of his symptoms. He has vigor to spare. All of us use protocols for sleep, exercise, nutrition, stress control, and more to navigate extremely demanding yet rewarding family and professional lives. None of us are naturals at this. We are passionate, hardworking, and yes, curious. But we are humans, which means we need tools for health and performance as much as anyone else.

Which brings me to the third essential player here: you.

I wrote this book for you, so you can benefit from the very same tools they use, and many others too. Podcast episodes are great, but what I have striven to do in the pages that follow is provide something different. The format is such that you can skip to any chapter, learn about the information there, and apply it easily. You can also read the book from start to finish. As mentioned before, the scientific themes build on one another, the same way they do in real life, in your body and brain. The protocols are organized in order of importance and impact for each chapter. Each begins with a series of steps that explain what to do. Then comes the science, which explores the mechanisms behind why they work. I also answer questions I'm frequently asked by friends, family, colleagues, and the general public.

One of my hopes is that from reading this book you will start to think about your health in a more scientific way. Try a given protocol, then pay attention to how it shifts your mental and physical health and your performance. I occasionally use the term *anecdata* to refer to these kinds of insights, ones based

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on a person's experience. Individual experiences are often dismissed because academic science does not generally consider a sample size of one person as evidence—except in formal case studies, of course. And yet, each of our lives is its own kind of laboratory. There is nothing wrong with giving credence to your own experience and to watching how something affects you as a source of data. The key is to become a *systematic observer* of you. See how starting a protocol affects your body, your emotions, or your productivity. Also take note of what happens when you stop doing a protocol—switching to the control arm of an experiment, if you will.

Of course, as you learn about the mechanisms that underlie the various protocols, I also hope you will come to appreciate the astonishingly beautiful thing that is our biology—the cells, organs, and interactions among bodily systems that create our mental and physical life. Surely, we are more than just a bunch of cells and chemicals. But those cells and chemicals are truly magnificent in their arrangements and power. *Protocols* is about tapping into, and leveraging, that power.

And so, we begin.

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CHAPTER 1



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Sleep is the subject of the first chapter of this book because sleep profoundly impacts every aspect of our physiology and psychology. Put simply, sleep is the foundation of our mental health, our physical health, and our performance.[1] We win by sleeping.

I came to that realization pretty early but only because I struggled with sleep. As a kid I slept like a log—always a solid eight to nine hours, rarely waking up in the middle of the night even once. As a teen I would stay out late and sleep in on the weekends, as most of us did. I never thought about my sleep.

When I reached my junior year in high school, however, everything changed. I would lie down, fall asleep right away, but then wake up three to four hours later, wide awake. Then I would toss and turn. Eventually I would fall back asleep but then needed to sleep really late into the morning to feel rested. School started at 8:00 a.m., so that wasn't an option most days. That had me falling asleep in class, feeling wide awake in the evening, and then the whole cycle would repeat.

Toward the end of high school when I started getting into fitness, I learned that we recover from exercise during sleep. That was the early 1990s and the public was not yet aware of the importance of sleep. There was some science on it—in fact some of the best work on the role of sleep for health and

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cognition was coming from the Stanford Sleep Lab just a few miles up the road from where I lived. But it was from a prominent trainer in the world of fitness that I first learned to take sleep seriously. He gave me one mostly good suggestion for sleep, and one terrible one. The mostly good suggestion was to read the work of Allan Hobson—a sleep researcher from Harvard—and I eventually did, although I discovered Allan's focus was mainly on the importance of dreams, which felt like a bit of a tease for someone with sleep issues. The terrible advice he gave me? He told me if I woke up in the middle of the night and couldn't fall back asleep that I should drink a half mug of white wine. I was seventeen! I tried it anyway, and it didn't work for me. Thankfully. We now know alcohol greatly reduces the quality and restorative properties of sleep, even if it does help some people fall asleep.

Eventually I figured out how to master the art of getting a great night's sleep, but it took time. Years, in fact. The science progressed too, of course, and we now know a lot about both the importance of sleep and ways to remedy pretty much any sleep issue. I wish I had the information you are about to read back in high school, and college, and graduate school, and my postdoc. The reality is, the busier we are, the more important sleep is to our health and performance. But no matter how busy or calm our life is, a great night's sleep is crucial to our mind and body.

If you are like the majority of people, and you struggle to get a great night's sleep, you want to remedy that as soon as possible.[2] But even if you are one of those rare individuals who sleeps deeply every night and wakes up feeling fully refreshed every day, there are still ways to improve your sleep and thus, your quality of life. Regardless of which category you fall into, this chapter will help.

I'd like to mention here that this chapter is a long one. We go deep into the science of sleep, but I promise you it's all made accessible. I know that understanding this science will help you get a great night's sleep. I wrote this chapter so you can browse by topic or tool. Start with the parts that interest you most, or the protocols that you think will help you right now.

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I prefer to focus on the benefits of doing things correctly, but when it comes to sleep, it's worth thinking a bit about the downsides of getting things wrong too, and learning to avoid those. Sleep deprivation—a term that means getting too little sleep or waking up too many times during the night—has been linked to significantly elevated risk of heart disease, stroke, and numerous hormonal imbalances involving—just to name a handful: cortisol, estrogen, testosterone, and insulin, the latter of which can cause type 2 diabetes.[3] Obesity, mental health issues, physical injuries, cancer, car accidents, depression, hypertension, and age-related dementia have all also been linked to poor sleep.[4] Sleep deprivation doesn't necessarily *directly* create these problems; rather it impairs cellular mechanisms that cascade to produce multiple issues within and between different organs and systems.

To be clear, everyone has a bad night's sleep now and again. But here's a good goal for you: Aim to sleep well 90 to 95 percent of the nights of your life, and allow the remaining 5 to 10 percent of those nights to be bad due to uncontrollable negative circumstances, like a work conflict, or joyful experiences, like a great party. Do your best to make sleep a top priority so that the rest of your life can be that much better.

Perhaps you have heard some of this before. Most people know a bit about the benefits and importance of sleep. As I mentioned above, that is a fairly recent development. It was about a decade ago when Matthew Walker, who formerly directed the Center for Human Sleep Science at the University of California, Berkeley, and is currently at the University of Texas in Dallas, wrote the now famous book, *Why We Sleep*. At that time, the "I'll sleep when I'm dead" or the "I'll catch up on sleep this weekend" mentalities prevailed.[5] Thanks in large part to Matt's book and other public education efforts, people now recognize they *must* sleep, yet the majority of people still don't sleep well and far too many people sleep poorly, with nearly half of adults reporting their sleep satisfaction as an "F"—meaning the lowest possible grade.[6] It is true that we all have slightly different sleep needs.

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Some of us consider ourselves morning larks. We prefer to rise early. Others are night owls who prefer to stay up late. These are what sleep researchers call chronotypes: genetically determined features of the chemicals, cells, and circuits that regulate when we prefer to go to sleep and wake up. You can blame your parents for your bedtime (and wake time) preference.

Separate from your chronotype is the total amount of sleep you need. Some of us need six hours to feel fully rested, others need eight, and some people feel great with just five. I should point out, however, that the feel-great-on-five folks are exceedingly rare. Most people need seven to eight.[7] But as mentioned above, according to recent reports from the National Sleep Foundation and the Centers for Disease Control and Prevention (CDC), at least a third of Americans do not get nearly enough sleep—and that statistic is likely to be a vast underestimate given the enormous increase in time spent on social media and online nowadays.[8] In fact, that figure skyrockets to more than 75 percent among high school students. That's right, approximately three-fourths of teens are not getting enough sleep,[9] which is extremely concerning given that our adolescent and teen years are when much of our brain wiring related to mood and behavior regulation, as well as attention and learning, gets solidified. From birth until about age twenty-five is an especially sensitive and time-limited phase, or what is called a *critical period*.[10] And the thing about critical periods is eventually they close: While our brains remain plastic our entire lives, the amount of neuroplasticity possible in those first twenty-five years far exceeds what is possible afterward, so teens can't simply make up for their lost brain wiring later on.[11] We have no idea what the long-term consequences of this kind of chronic sleep deprivation are, but we do know that far too many young people are missing out on sleep at exactly the time when they need it most.

Compulsive overuse of phones and other screen-based technologies at night is a major factor for the poor sleep of adolescents and teens, but also

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for the poor sleep habits of adults.[12] A central feature of life in the twenty-first century is to always be connected online and by text. So much so that by the classic definition of shift work, many—perhaps even *most* people—worldwide, now meet the definition of a shift worker, that is, awake for two to three hours between 10:00 p.m. and 5:00 a.m. Shift work is not just about staying up late but also involves reduced amounts of exposure to sunlight during the day, lack of sufficient darkness at night, and a nocturally-shifted eating schedule. That has well-established negative health effects, including poor gut health, mental health deficits, and even decreased lifespan.[13] So this is no trivial matter. Smartphone technologies are not to blame per se, but when we use those technologies certainly is. We can scroll 24-7 and unless we resist, the light from our phone, tablet, or computer screen impairs our sleep. Not to mention that the content we absorb on those screens often affects our sleep, too, because of the elevated levels of arousal—aka stress—that content creates. Even if being on our phones or tablets in the hours before sleep doesn't stress us out, it can disrupt our sleep.[14] We rarely hear how texting alters our sleep patterns but I would argue that for many people, it is at least as pernicious as social media in this regard. To be clear, texting is a wonderful tool for communication; it allows us to connect quickly. And social media can be a good source for learning, social connection, and entertainment. The downside, however, is that we can have conversations and observe events at any time of day or night. If we wake up in the middle of the night, we know we should roll over and go back to sleep, but many of us instead start reading and sending texts, or scrolling the internet or browsing social media.

So it comes as no surprise that most of us now qualify as shift workers but very few of us are sacrificing our sleep hours by doing actual work.[15] We have all become so habituated to this new normal of consuming content and communicating at all hours that we don't see how out of sync it really is with our sleep and therefore our health.

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The good news is, we can fix our sleep duration, quality, and even determine its timing—regardless of our chronotype—without having to disengage too much from these technologies.

And it's oh-so-worth it because when I say, "We win by sleeping," I am referring to the fact that sleep shapes everything about us—how we look, how we think, and how we feel. But I also mean that if you get your sleep right 90 percent of the time, you'll be absolutely amazed how your appearance, health, and performance will improve. The data say you'll likely live longer as well.[16]

This chapter offers protocols you can easily integrate into your life to get far more restful and restorative sleep. That is, to "sleep better." None take much time, and many of them are downright pleasurable. Let's consider these protocols in order of their importance.

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SLEEP PROTOCOL

1

View Sunlight as Soon as Possible After Waking

WHAT TO DO:

- **Get morning sunlight in your eyes as soon as possible after waking.** Go outside and look in the direction of the sun for at least five to ten minutes each morning. Your goal should be to get sunlight in your eyes within the first thirty to sixty minutes of waking up.
- **A few things to keep in mind.** If you wake up before the sun rises, you'll obviously have to wait. If you can view the sun as it comes up across the horizon, great, but that's not vital for this protocol to work.

  Morning sunlight, as we will review, differs in quality from sunlight at other times of the day. It is best viewed by facing the sun without any physical barriers, like awnings or buildings, obscuring your view. Don't wear a brimmed hat, as it blocks some of the light that would otherwise reach your eyes from overhead. Wearing eyeglasses or contacts is fine but, alas, this protocol won't work nearly as well through a window or windshield, as that will filter out many of the relevant wavelengths of light. Skip the sunglasses while doing this protocol. What about clouds? No matter how overcast, there is always some sunlight coming through once the sun is up. In fact, the more accurate way to state this protocol would be "get as-early-in-your-day-as-possible *daylight* in your eyes," but that is a mouthful. The point is that the sun provides daylight even on overcast days. Just compare how bright it is at 8:00 a.m. on an overcast day

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to midnight the night before. So forget the "there is no sun out in winter where I live" argument. There is daylight, and you want to view it. Indeed, this protocol is especially important on cloudy days.

Caution: Do not stare at the sun. Never force your eyes to stay open. Allow your natural squint and blink reflexes to protect your eyes. If the sun still feels too bright, look a few degrees to the side of the sun.

HOW IT WORKS:

Correctly timed sunlight viewing—especially morning sunlight viewing—is immensely beneficial to our overall health. This simple, zero-cost protocol powerfully affects your daytime mood, focus, and alertness, and improves your sleep, which further improves your health and performance in myriad ways.

The power of this protocol arises from its impact on three synergistic elements: your circadian clock, your eyes (or more specifically, the nerve cells in your eyes that detect sunlight and communicate its presence to your circadian clock), and specific qualities of light that come from the sun, especially when it is low, relative to the horizon. Together, these three elements make up a robust network that drives many of the biological processes in your brain and body.

I first learned about the importance of viewing morning sunlight from one of the world's preeminent sleep researchers, Seiji Nishino, MD, PhD. I was working in his lab at Stanford during a summer home from college, and I noticed he would always stop to face the sun for a few minutes before going into the lab for the day. Even if he arrived at the lab before sunrise (not uncommon for researchers in a sleep lab!), he would make sure to step outside shortly after sunrise and face the sun for a few minutes before returning to work. That was way back in 1996—when our understanding of the mechanisms of human circadian biology was rudimentary compared to now. Seiji explained that viewing morning sunlight felt good, that it gave him more energy for the

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day, and that it improved his sleep. I started joining him and joked that we resembled the many ground squirrels around us up on their haunches doing the very same thing. Little did I know that the exact same morning sunlight-sensing cells, circuits, and mechanisms were at play in us and those squirrels and, in fact, in every mammal where they have been examined.

I quickly noticed that on days I viewed morning sunlight, I also felt good, had more energy for the day, and slept better at night, so I kept with it. You should experience those benefits, too, because of the way morning sunlight—whether on a clear or cloudy day—kickstarts a powerful set of hormonal and neural mechanisms that positively shift the state of your entire brain and body for many hours afterward. It can work the first time and every time, and once you understand a bit about those mechanisms, it will allow you to easily adjust this protocol to your schedule and circumstances to derive the maximum benefits with minimal time investment.

Your Circadian Clock

Located a few centimeters above the roof of your mouth is a small cluster of neurons called the *suprachiasmatic nucleus*, or SCN.[17] The SCN is your master circadian clock. Its job is to coordinate the activities of all the cells and organs in your body into a coherent twenty-four-hour rhythm so that certain cells and organs in your body are more active, and other cells and organs are less active, depending on the phase of that twenty-four-hour rhythm. The SCN keeps your body and brain on schedule.

The first documented discovery of a circadian clock came not from studies of humans or even of rodents, but of plants. In 1729, a French astronomer named Jean-Jacques d'Ortous de Mairan noticed that a mimosa plant kept in a totally dark room continued to rhythmically fold and unfold its leaves every twenty-four hours, just as if the sun was shining through the window.[18] It was a mystery: If the plant was not unfurling to absorb sun or other light, then what was guiding its movements? About two hundred years later, Ger-

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man biologist Erwin Bünning tracked the movements of bean plant leaves and reported that they followed a cycle lasting 24.4 hours. Observations such as these confirmed that plants had internal, or what scientists call "endogenous," clocks that followed what later became known as . . . a circadian rhythm, named for the Latin *circa diem*, or "around a day." And as decades of research would eventually confirm, the vast majority of organisms on Earth—not just plants but also insects, rodents, reptiles, and all mammals, including humans—have an endogenous timekeeper that keeps a twenty-four-hour circadian rhythm, even in the absence of any external cues about the status of the outside world.[19]

Our core body temperature, the release of certain hormones, and most notably our sleep-wake cycle, all follow a twenty-four-hour circadian rhythm.[20] Even when scientists extracted individual cells from the body, the cells continued to follow this rhythm.[21] And which genes they expressed and when, the proteins downstream of those genes, the cells' enzymatic activities—indeed not just *some* things but nearly everything about cellular function—appeared to vary, not randomly, but rather systematically every twenty-four hours. That was remarkable.

But what is equally remarkable is that all cells in our body can coordinate their individual rhythms in a manner that is timed perfectly with one another—like a well-practiced symphony, except this symphony involves not a few hundred or even a thousand participants, but trillions. And just like a symphony, it is not as if every cell simply needs to start and end its activity at the same time. Some cells need to be active at the same time, or *in-phase* with one another; some need to be active at opposite times, or in *anti-phase*, and still others repeat their cycles of activity faster, then slower, then faster, again with a unique signature and yet, still repeating once every twenty-four hours. And the start and end time of each cell's twenty-four-hour rhythm must be tightly bound to all the other cells of the body, just like the start and end of a symphony. Without this coordination, you end up with noise rather than

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music, illness rather than wellness. The only difference is the symphony that is your physiology never ceases; it repeats every twenty-four hours, from the day you're born until the day you die.

The basis of that persistent and extraordinarily precise biological coordination remained a mystery until somewhat recently. Clues came from multiple sources. First, studies in which people were placed into constant dark environments—such as caves or windowless bunkers—confirmed the existence of a circadian rhythm in humans. Back in 1938, two physiologists spent a month in Mammoth Cave, Kentucky (perhaps figuring this experiment was best done on themselves before asking anyone else to try it).[22] There, they confirmed that human body temperature has a circadian rhythm whereby it increases upon waking, decreases approximately ten to twelve hours later, drops to its nadir during sleep, then rises once again—all once every twenty-four hours, even though the subjects/researchers had no access to sunlight or other cues about time of day. And other studies confirmed that, in the absence of an alternating pattern of ambient light and darkness, the human body still maintains a circadian rhythm for numerous aspects of our physiology.[23]

In 1966, a German physician named Jürgen Aschoff initiated what became known as the bunker experiment, in which subjects (not researchers this time!) spent several weeks in a sealed bunker, living life as usual but without any windows or other ways to determine the passage of time.[24] They found that subjects generally spent about one-third of each twenty-four-hour period sleeping and two-thirds of it awake, just as most humans living aboveground do. However, the wake-up and to-sleep times of the people in the bunker drifted—they woke up slightly later and went to sleep slightly later each day. Thus, the bunker experiment confirmed the existence of a circadian rhythm, but one that requires some external cue to anchor it. What remained mysterious was the biological basis of the circadian clock—was it a bloodborne factor? In the liver? In the brain? In the pineal gland? Theories abounded

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but none of them held up to experimentation. And another major question remained: In the environment outside the bunker, which external cues were responsible for setting that clock to a specific start and finish time each day?

Subsequent discoveries, first in rodents and later in humans, revealed the existence of a small cluster—or what is called a "nucleus"—of neurons located a few centimeters above our mouths that had a key part to play. It was later named the suprachiasmatic nucleus (SCN) for "above the chiasm"—the chiasm being the location at the base of the brain where the nerve fibers from both eyes partially cross. As I mentioned earlier, the SCN is the master circadian clock: the structure that coordinates the activities of all our cells and organs. In other words, the SCN is the orchestra conductor that makes sure each cell's twenty-four-hour rhythm starts on time.[25] In 1972, Irving Zucker's lab at UC Berkeley and Robert Moore's lab at the University of Chicago independently discovered that lesions to the SCN render organisms' circadian pattern arrhythmic and disorganized.[26] Naturally occurring SCN lesions caused by tumors eventually showed the SCN is necessary for sleep-wake, hunger, and other bodily rhythms to obey circadian cycles in humans as well.[27] Moreover, animal studies showed that transplanting even just a small number of healthy SCN neurons into an arrhythmic brain restored a coherent twenty-four-hour rhythm, proving the SCN is both necessary and sufficient for endogenous circadian rhythms.[28]

If ever there was a brain structure whose function is beautifully organized to help ensure our survival as a species, it is the SCN. Even the SCN's seeming imperfection turns out to be perfect after all.

Stay with me here. For example, the SCN generates a period—meaning a cycle length—that is close to but not quite twenty-four hours. The SCN's period tends to be a bit longer than that, up to 24.5 hours.[29] By virtue of this, it can shift the start of the circadian rhythm forward or backward according to seasonal changes in day length or other survival-based needs, without making a mess and setting our cells on different schedules.[30] In other words, allowing

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a little room in its period duration affords us more flexibility and overall precision, not less, which is great because as we all know life is rarely the same from one day to the next. What's more, it is also what allows for *phase shifting*,[31] or the ability to change the start time of the daily cycle. If you're wondering why this doesn't have us waking up later and going to sleep later each day, it's because viewing morning light and evening light nudges your clock back and forth perfectly, to keep it regular. Later I'll explain how you can leverage that to overcome jet lag or any new schedule fast, but for now, all you need to know is that the not-exactly-twenty-four-hour rhythm is a feature, not a flaw.

As you probably already realize from the call to action that is Sleep Protocol 1, our SCN cares about whether it is light or dark out. And of course light-dark cycles are set by the spin of the earth. But how is it that our SCN—a tiny cluster of neurons embedded deep in the darkness of our brains—"knows" about the spin of the earth? Let's consider how to answer that question with insights from planetary science and cosmology.

We're all on this big sphere in space, spinning around at about one thousand miles per hour, causing us to face the sun, then away from the sun, then back toward the sun every twenty-four hours. Because the earth is round, the exact duration of sunlight we can experience each day depends, of course, on where we happen to be on earth. The variability is large, ranging from rather equal light-dark splits at the equator to nearly full days and/or nights of darkness or sunlight exposure at the poles. But no matter where we are on earth, inside each of our brains, our SCN steadily churns out that slightly longer than twenty-four-hour rhythm of coordinated cellular activity across our whole body.

Ultimately it is our SCN that tells us when to sleep and when to wake. We are a diurnal, not a nocturnal, species. We can stay up late and sleep all day if we choose, but even for night owls, all our bodily systems of hormones and neurotransmitters, our immune system, our levels of focus and quality of that focus, all of it, function much better when we live diurnally and wake

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just before or during the early daylight hours and go to sleep some hours after sundown.[32] (Yes, night owls would be wise to do this too—that is, if mental and physical health are your priority.)

Keep in mind these are independent phenomena; the earth's spin and travel around the sun is not what causes our SCN to have a twenty-four-hour rhythm, nor does it tell us when to sleep and when to wake, but they do need to be linked. So how do we link—or what is called *entrain*—our SCN's rhythm with the light-dark cycle generated by the earth's spin and travel around the sun? Remember, our SCN resides deep in our brain. It lives in the darkness of our skulls. To synchronize our circadian clock with the day-night cycle cast on us by our location on earth, we need a way for the presence or absence of sunlight to be conveyed to the SCN. And the best way to do that is to call upon the one part of our brain that has direct access to sunlight: our eyes.

Your Eyes

Wait, did I say that your eyes are part of your brain? Yes, that is correct. Lining the inside-back part of each of your eyeballs is a thin sheet of brain tissue called the neural retina. Your neural retinas were squeezed out and away from the rest of your brain during the first trimester of your life, while you were still in your mother's womb, and then grew wirelike extensions into the brain proper, forming two optic nerves. Your optic nerves convey electrical signals about the presence or absence of sunlight, objects, faces, moving vehicles, and on and on to different brain areas, including—you guessed it—the SCN.[33]

The connections between your eyes and your brain are truly a spectacular product of biological engineering. First, they solve the problem of how to inform image-forming regions of your brain about "what is out there" in the world, so you can see faces, moving objects, and colors. They also solve the problem of letting your SCN know "*when* it is out there" in the world, by the presence of sunlight. The neurons that convey the presence of sunlight to the SCN are not of the image-forming kind; they don't respond to the shape of the sun, but instead

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to its brightness and to the specific wavelengths of sunlight that reach your eyes when the sun is low in the sky. We refer to these specific wavelengths as low solar angle sunlight.[34]

Have you ever noticed that low solar angle sunlight appears more yellow than midday sun? Or even orange? Check out a sunrise or sunset and compare the color of sunlight to the color of sunlight at noon. Of course, sunlight doesn't change according to where it is in the sky, but what portions of sunlight are visible to us does.

Sunlight is always full spectrum: It contains all wavelengths of light, red-orange-yellow-green-blue-indigo-violet, or ROYGBIV, just as they taught us in elementary school. The R(ed), O(range), and Y(ellow) are longer wavelengths of light, the G(reen) is medium wavelength, and the B(lue), I(ndigo), and V(iolet) are shorter wavelengths. And of course, the sun emits UV and far-red, or infrared wavelengths, too, but we can't see those (although many other animals and insects can). When the sun is high in the sky, it appears white, because all the wavelengths of light arrive at our eyes at roughly the same intensities. When the sun is low in the sky, we see the sun as more yellow, orange, or red, because molecules in the atmosphere preferentially redirect the shorter blue, indigo, and violet wavelengths of light—a process called Rayleigh scattering. (We'll discuss the properties of light in depth in chapter 5.)

All mammals, us humans included, have evolved a special system of light detection that responds specifically to the presence and contrast of short and long wavelengths of bright light, which is exactly what reaches your eyes if you view sunlight early or late in the day, while the sun is fairly low in the sky. In other words, we all have a sunrise and sunset detecting system in our eyes that communicates the time of day to our SCN.[35]

As I mentioned earlier, this timekeeping eye-to-brain circuit is also a fairly recent discovery. And by recent, I mean *recent*: In the late 1990s, there still wasn't general agreement among circadian biologists whether light—and not

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some other cue like social interactions—was the dominant force entraining our SCN. Then, in 1998, neuroscientist Ignacio "Iggy" Provencio made a key discovery. Iggy found a molecule in the skin of an African frog species that caused its skin to darken when exposed to sunlight was also present in the eyes of mice.[36] The molecule was an opsin, which is a kind of protein that absorbs light, and when it does, it changes its conformation to set off a signaling cascade.[37] Since the same opsin was known to cause darkening of dermal melanophores in frog skin, Provencio called the mouse retinal opsin *melanopsin*. Other labs confirmed melanopsin-containing cells are abundant in the human retina, too, mostly in the lower portion that views the upper visual field, which, you might have guessed, corresponds to the sky.[38]

So we have a frog-skin-like set of cells in our eyes? Not quite. To explain what makes melanopsin-containing retinal cells so special, first a bit about photoreceptors. Photoreceptors are neurons that convert light into electrical signals the rest of the retina and brain can interpret. But the retinal cells that contain melanopsin are not like other photoreceptors. The melanopsin-containing retinal neurons Iggy discovered turned out to be both photoreceptive and retinal ganglion cells—the neurons that connect the eyes to the brain and the very cells whose wirelike extensions, or axons, make up the optic nerves. Soon after, a group of neuroscientists, David Berson and Felice Dunn at Brown University and Samer Hattar and King Wai-Yau at Johns Hopkins University, along with several of their students and postdocs, confirmed that melanopsin RGCs send their axons to the SCN *and* that they fire electric signals, thereby releasing neurotransmitters, when light is shone on them.[39] Remarkably, they did this when they were isolated from all other retinal cells. As long as the light shone was very bright and long lasting, they fired electrical signals. These cells were therefore named intrinsically photosensitive RGCs (ipRGCs) to differentiate them from the other 99 percent of RGCs that can't respond directly to light on their own. Some years later, work

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from the Neitz Color Vision Lab at the University of Washington in Seattle and by others showed that the optimal stimulus for ipRGCs isn't just bright light.[40] They discovered that the best way to activate the ipRGCs that connect to the SCN is with sustained very bright light, similar to what we see as blue or green light, contrasted with medium wavelengths of light, or what we typically see as yellow or orange—in other words, features prominent in low solar angle sunlight. The color contrasts in sunrises and sunsets tell your brain about what time it is in the twenty-four-hour cycle. That collection of work, from the discovery of melanopsin to ipRGCs, and how they work, was revelatory. It meant that there was a specific neural circuit extending from the eye to the brain dedicated to entraining the SCN and our circadian rhythms. That circuit is tuned to—neuroscience lingo for "responds to"—the presence of low solar angle sunlight. The SCN then handles the job of body- and brain-wide synchronization of circadian rhythmicity. This sunlight-driven circadian entrainment circuit requires no learning or practice to activate. It is present from birth and functions the first time and every time to control, among other things, your sleep-wake cycle.

The Sun

Which brings us to the final piece of the puzzle—the part that is not hardwired but that you control with your behavior—and that is the call to action of this protocol: exposing your eyes to morning sunlight (or in its absence, to the next best alternative, which I describe below). Doing so activates the ipRGC-to-SCN circadian entrainment circuit and initiates dozens of beneficial processes that get and keep your brain and body going throughout the day. And toward the evening, it puts you in the best possible position to get a great night's sleep.

In fact, we have copious evidence that this is foundational to both our daytime well-being and nighttime sleep. As one small example, a group of archi-

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tects and neurologists came together in 2014 to investigate how windowless offices affected the people who worked in them.[41] They asked twenty-seven office workers who had either no windows, or work areas situated far from windows, and twenty-two people working in offices with windows, about their well-being and sleep quality. The questionnaire scores were decidedly poorer among the windowless workers. They reported more sleep disturbances and an overall unsatisfactory quality of sleep.

In the early 2000s, a group of chronobiologists (scientists who study biological timing) at the Institute for Medical Psychology, in Munich, Germany, surveyed five hundred people about their sleep times, light exposure, and chronotype—as in, morning person, night owl, et cetera (you'll find out how to determine yours in Sleep Protocol 4).[42] They found that the amount of light exposure during the day correlated with what time people went to bed: More exposure during the day meant earlier bedtimes. This link can be partly explained by external factors, like employment: People whose livelihoods depend on being outdoors are more likely to be early-to-bed types, especially if their work requires them to rise early or is physically demanding. But that doesn't explain the connection entirely. It turns out that it's also due, in part, to the fact that exposure to daylight has a regulating effect on our physiology—causing elevated levels of alertness by a host of different pathways, including hormonal and neural pathways. As one review put it, "In sum, research seems to agree that daylight (at high intensities) is beneficial for sleep."[43]

There are also numerous studies showing that bright-light exposure early in the day—at the intensities that one would get from being outdoors in the morning—is beneficial for everything from mood to hormone health, daytime energy levels, and on and on.[44] But before you say, "Okay, got it!," there's just a bit more to understand about the underlying mechanisms in this protocol, and that's the relationship between sleep and wakefulness. And it will help

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you get the most out of this protocol, regardless of where you live and the time of year.

Our daytime levels of alertness reflect the quality and duration of our nighttime sleep. That's a giant "duh." We all know that if we sleep poorly, we drag both mentally and physically the next day. We also all know that if we sleep great, we're focused and motivated to do all kinds of things that require energy . . . and that we have the energy to do them.

But what most people do not know is that the relationship between sleep and wakefulness works in the other direction too. When we are alert during the morning and daytime, we are more likely to expend mental and physical energy that in turn helps us sleep at night. Even those of us who sleep well typically find that increasing our daytime physical activity—especially in the hours between sunrise and 2:00 p.m.—leads to significantly better sleep,[45] which in turn leads to more energy the next day, which improves sleep, and so on. Again, you're probably thinking, "This is common knowledge. Do we really need science to explain this?"

Here is the lesser-known fact: Morning sunlight viewing is the best way to increase our morning and daytime energy levels.[46] Not food (although fine to eat early in the day), not caffeine (also fine). It's morning sunlight.

Morning sunlight increases your energy levels through at least three different mechanisms. First, it suppresses any residual melatonin you may have circulating in your brain (Sleep Protocol 3 includes an extensive look at melatonin, a hormone that helps promote sleepiness).[47] As discussed above, when the ipRGCs are activated by sunlight viewing, they send electrical signals to the SCN. The SCN, in turn, stimulates a collection of neurons in the nearby paraventricular nucleus, or PVN. The PVN then sets off a cascade of signals that go through the spinal cord and back up to the pineal gland in the brain, shutting off melatonin production.[48] Voila! You've suppressed the primary hormone that promotes sleepiness by viewing morning sunlight.

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Second, bright light reaching your eyes helps suppress the action of adenosine, a chemical that also leads to feelings of sleepiness.[49] Sunlight does this indirectly via its effects on other systems in the brain and body, but nonetheless, it has a potent adenosine-reducing effect. (We'll take a deep dive into adenosine in Sleep Protocol 7). After a full night's sleep, adenosine levels tend to be low, but if you happen to not get enough sleep (as so many of us do), morning light helps reduce any residual adenosine. That both increases your alertness and prevents the residual adenosine from delaying your circadian clock, which would otherwise bias you toward waking up later the next day, then going to sleep later, then waking up even later the following day, and so on (what chronobiologists call a *phase delay*).[50] Such circadian "drift" brought on by mild sleep deprivation is very common. It is best remedied by viewing morning sunlight to reset your circadian rhythm.[51]

Third, we need to talk about cortisol. Because it's often discussed in the context of chronic stress, which is bad, most people think cortisol is "bad" too. But it's not bad. Cortisol is essential to health and your levels of energy—you just don't want your cortisol levels to be elevated at the wrong times.[52]

Your SCN is located in your hypothalamus (H), which is part of a biological circuit that also includes your pituitary gland (P), a small, stalk-like protrusion at the base of your brain that releases hormones into your bloodstream. The circuit also includes your adrenal glands (A), which reside atop your kidneys. This circuit is known as the HPA axis.[53] The HPA axis is one of the main systems that responds to stress (which is why you'll hear more about it in chapter 3). Here's how it works: It starts with signals from the hypothalamus, which then stimulate the release of specific hormones from the pituitary, which in turn stimulate adrenaline and cortisol release from your adrenals.

The HPA axis is also involved in the sleep-wake cycle. When your ipRGCs are activated by low solar angle morning sunlight and your SCN receives the ensuing signal, it alerts your adrenal glands to release adrenaline and corti-

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sol via the HPA axis.[54] Cortisol and adrenaline dramatically increase levels of alertness, the latter likely by activating receptors on your vagus nerve,[55] a large portion of which extends from the organs in your body up into your brain and stimulates areas there such as the locus coeruleus to make norepinephrine, which has the net effect of "waking" you up.[56] Cortisol does a lot of things. It also decreases inflammation and regulates our immune systems to protect against viral and bacterial infections.[57] And it helps regulate our energy levels. Think about cortisol as a wakefulness-promoting hormone, not a stress hormone, if you want to understand what the cortisol in your body is doing most of the time. It's also useful to consider how cortisol ebbs and flows across time due to signals from your circadian clock. By measuring cortisol levels every twenty minutes in human subjects, researchers found cortisol reaches its apex at about sixty minutes or so after you wake up and that it is lowest about four to five hours after you fall asleep.[58] Then it begins to rise sharply across the final two to three hours of your sleep until—boom! You wake up due in large part to what is called the cortisol awakening response (CAR). Yes, reaching a threshold level of cortisol is a major factor in what ultimately rouses you from sleep. As mentioned above, your cortisol continues to rise and peaks about sixty minutes after waking, then slowly drops down as you head into the early and late afternoon. Cortisol levels generally stay low and continue to drop in the evening and at nighttime (assuming it doesn't spike from stress or intense exercise—more on that below), and then it falls to its nadir in those first four to five hours of sleep before starting to rise again toward morning. We return to this *circadian cortisol curve* in chapter 3, and the role it plays in promoting health in women and men of all ages. For now, the key thing to know is that for cortisol to support our health, it needs to peak in the first hour or so after waking; it then needs to drop precipitously in the evening and night and continue falling to reach its nadir in those initial four to five hours of sleep.[59]

Viewing morning sunlight doesn't directly cause the morning peak in

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cortisol, but it can dramatically amplify its rise by as much as 50 percent.[60] This also helps ensure that this peak comes early in the day and isn't shifted to the afternoon. Late-day elevations in cortisol have negative consequences over time such as sleeplessness, anxiety, and metabolic disease.[61]

A quick note: A morning workout, morning caffeine, and breakfast (provided it isn't a huge and/or carbohydrate-laden one) will all promote wakefulness, too, and thereby contribute to a well-aligned circadian rhythm. But morning sunlight is the most potent lever for increasing morning cortisol and thus energy during your day, and for improving your sleep at night. Don't underestimate its power.

Keep your circadian rhythm attuned to the sun, and all of these mechanisms will work as they should.

COMMON QUESTIONS:

It's often dark when I wake up. What do I do if I have no access to morning sunlight but I want to start my day?

If you wake up before sunrise, and you want to start your day, I suggest turning on as many bright indoor lights in your home—or hotel room, or wherever you may be—as possible. Sunlight cannot be replaced by standard indoor lighting, but turning on indoor lighting first thing won't hurt. Then get outside to view morning sunlight once the sun is up.

If you wake before sunrise every day, or if you live in a part of the world where it is very dark in winter, you may want to invest in a 10,000 lux light to help ensure you get enough light in the morning (lux is a measure of brightness). Most cost about $100, and some are portable for travel. I often wake up before sunrise, and because the ipRGCs can be activated by very bright artificial lights if those bright lights include sufficient short wavelengths, I keep a 10,000 lux lamp in my kitchen and bathroom.[62] It

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lacks long wavelength light, so I also have a red incandescent light next to it and I turn that on too. I use the red incandescent light from SaunaSpace (no affiliation). I turn them both on first thing in the morning and then I get outside to view morning sunlight once the sun is up. I am well aware these lights are not a replacement for sunlight, but they help bridge the gap until the sun is up. Once the sun is up, you can be sure I go outside to view it!

And I will sometimes keep the 10,000 lux lamp and a red incandescent light on and facing me for an hour or so once I'm back working at my desk or getting ready for the day. Chapter 5 further explains the logic and benefits of this extended morning light exposure. There I also mention options that can be of real help for sleep as well as other aspects of health too, such as metabolic health.

But remember, morning sunlight is the best stimulus for your ipRGCs, SCN, and circadian rhythm, and it costs nothing! Figure out how to view it each morning. Again, you don't need to see it cross the horizon as it rises. If you do, great, but if you wake up after sunrise, that's fine. Do your best to view sunlight within the first thirty to sixty minutes after waking up. Bring your coffee or tea outside with you. Bring your spouse or kids if they're awake. Bring your dog if you have one. Remember, dogs, cats, cows, and other animals have ipRGCs and an SCN, too, and they benefit from morning sunlight in many of the same ways and via the same mechanisms as we do.[63]

What if it's cloudy outside?

To activate your ipRGCs fastest, go outside and face east toward the sun on a nice, clear morning with no clouds in the sky. Obviously, this isn't possible for everyone every day.

Again, fortunately, sparse clouds do not interfere with the interaction between sunlight and our circadian clock. However, if the sky is densely overcast

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and gray, a 10,000 lux light can be a real help, but still aim for getting more sunlight in your eyes to compensate for the lower intensity of sunlight and reduced yellow-blue contrast exposure you're likely to get on very overcast days. In fact, it's *especially* important that you get sunlight in your eyes on overcast days. This is for three reasons: (1) dense clouds reduce the number of photons reaching your eyes in a given amount of time; (2) they filter out much of the longer (yellow, orange, and red) wavelengths of light, and (3) you are likely to be indoors more on cloudy days, which can cause the SCN to fall out of sync with the solar cycle, which leads to later nights, more artificial light exposure at night, more circadian disruption, and so on.

Aim to extend the sunny, clear day recommendation of a minimum of five to ten minutes, to at least fifteen minutes on cloudy days, and thirty minutes (minimum) on densely overcast days. That may seem like a long time, but remember, you don't need to stand in one place gazing at the sky. Take a walk. Make a call. Listen to a book or podcast or talk to a friend, partner, or other family member. And even if you can't be outside for the full time recommended above, some sunlight hitting your eyes in the morning is better than none. If you miss a day completely due to travel or sickness or other reasons, don't despair—your energy levels that day may be lower because you didn't get the cortisol spike bright morning light causes, but your circadian rhythm is the reflection of your previous three to four days of sunlight viewing activity.

Do I need to worry about sunlight damaging my eyes?

Excessive UV light exposure can cause cataracts and, as we have all heard, skin damage, accelerated skin aging, and some forms of skin cancer, topics I cover in more detail later in the book. But viewing morning sunlight is much safer than viewing overhead midday sunlight—because that Rayleigh scattering of short wavelength light when the sun is low in the sky includes UV and thus reduces your UV exposure significantly. It is when the sun is overhead

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that the UV index is high. UV light isn't bad, per se, but you don't want too much of it reaching your eyes or skin. Chapter 5 goes into the benefits and drawbacks of UV.

NEVER, EVER force yourself to stare at the sun—or any light source for that matter, at any time of day. Your natural blink and "look away" reflex is a built-in circuit (yes, there is a dedicated circuit for this) to protect your eyes. People with macular degeneration or other eye conditions ought to be especially careful about viewing midday sunlight, and if very sensitive to sunlight, they may want to consult with their ophthalmologist before doing any deliberate sunlight viewing.

What about eyeglasses and contact lenses?

Eyeglasses and contact lenses are both perfectly fine to wear while viewing morning sunlight. Neither one blocks light from reaching your eyes, even if your eyeglasses or contacts have UV filters.

Sunglasses and transition lenses, however, should be avoided while viewing morning sunlight because they block out a lot of the relevant wavelengths that trigger the valuable mechanisms covered in this protocol. Moreover, they reduce the number of photons reaching your eyes. Of course it's fine to wear sunglasses as needed for comfort and safety at other times of day.

What about viewing sunlight through a window or windshield? Is that the same?

People relentlessly ask me this and my response is equally persistent: No, it's not the same. It's far less effective, though better than nothing. But if there is any way to get outside, do. Windows and windshields, especially nowadays, filter the intensities and wavelengths you want for this protocol to work. "How come viewing morning sunlight through eyeglasses or contacts is fine but not windows or windshields?" you may wonder. Because windows do something

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called spectral filtering: They reduce the amount of light—especially short wavelength light—that would otherwise reach your eyes. Corrective lenses don't; they let far more light through. That's their job. Well, that and to correct any optical errors in the structure of your eyeballs so you can see things clearly. Windows and windshields do neither.

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SLEEP PROTOCOL

2

View Sunlight in the Late Afternoon

WHAT TO DO:

- **Get sunlight in your eyes in the late afternoon or early evening.** Ideally, go outside and spend at least ten to fifteen minutes there before the sun sets. If at all possible, face or walk west toward the sun. You do not need to see the sun drop below the horizon. That's a wonderful thing if you can—who doesn't love a sunset? Alas, most of us don't live or work in the right place to do so. Luckily, just going outside and getting some ambient light in your eyes in the late afternoon or early evening is beneficial. Seeing the sunset is a bonus.
- **A few things to keep in mind.** As with the previous protocol, it is best to face the sun directly, not through a window or windshield, and without wearing sunglasses or a brimmed hat. Perhaps you can get an unobscured view by going up to a rooftop or by walking a few blocks from where you work or live. From a health perspective, that is well worth it. Again it's especially important to do this protocol on overcast days.

HOW IT WORKS:

We've already unpacked the basic physiological processes linking your circadian clock, your eyes, and specific qualities of light that drive the sleep-wake cycle. Afternoon sunlight exposure taps into some of the same basic underlying cells, circuits, and mechanisms, but has both distinct and added benefits,

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including partially protecting you from some of the negative health effects of viewing artificial lights late at night.

Here again we start with the SCN. Earlier I described the SCN as a "cluster of neurons," but that doesn't really do it justice. A key feature of the SCN is that it contains two oscillators, each following a roughly twenty-four-hour rhythm of electrical activity, but offset from one another.[64] It's as if they are singing in a round, with peaks happening at different yet specific moments within the twenty-four-hour cycle. One peak roughly corresponds to morning and the other to evening, and each can be entrained to sunrise and sunset. And they communicate with one another to be sure neither the morning nor the evening oscillator runs too fast or too slow. That helps generate the SCN's coherent daily rhythm that all other cells in the body follow. It also allows us to shift our clock forward or back as the lengths of days and nights change across the seasons.

Here's the best way to think about it: These two oscillators are like bookends buttressing a row of vertically stacked books, making the books less likely to fall over. This is the right analogy given that viewing morning sunlight shifts the phase of our circadian clock forward, making us want to go to sleep earlier and wake up earlier. Viewing late afternoon or early evening sunlight delays the phase of our clock, which, because it shifts the timing of the release of hormones like melatonin, makes us want to go to bed later and wake up later. So viewing both morning and afternoon sunlight thus helps keep us on a regular sleep-wake schedule, because the phase shift effects of morning and evening sunlight offset each other.[65]

Another great reason to view sunlight in the late afternoon or early evening is that it helps buffer us against the negative effects of viewing bright artificial lights at night.[66] In the morning, we need to see a lot of bright light to train our SCN with the solar cycle, and to elevate our levels of alertness. Unless it's a 10,000 lux lamp, most artificial lights and certainly our phone or computer screens just can't do the job at that time. After sundown, however, it takes extremely little bright light to quash our melatonin levels, and shift

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our circadian clock. And even if we can still fall asleep at night, that sleep is not going to be as high quality.

In fact, studies show that as little as fifteen seconds of bright light can significantly shift our circadian clock.[67] And while most screens are not as bright as the lights used in these studies, our ipRGCs and SCN work to sum photons—that is, add up all the light we see from various sources. And let's face it, most people are looking at their phone and other screens for a lot longer than fifteen seconds after sundown.

To recap: In the morning, you need more bright light in your eyes than a screen or conventional home lighting can provide, and at night you want far less light reaching your eyes than typically comes from a phone or computer screen or conventional home lighting. It all has to do with how our eyes are more sensitive to detecting light at different times of day or night. If that seems inconvenient, you're right; nowadays it is! But the circuits underlying retinal and circadian sensitivity across the twenty-four-hour cycle evolved long before humans had artificial lighting, much less the bright, short-wavelength-enriched LED screens and LED bulbs that we use today.

I, like most people, often wake up once in the middle of the night to use the bathroom. If I had things my way, our circadian system would be buffered from the phase-shifting effects of light at that time, but I wasn't consulted at the design phase, and our ipRGCs are *exquisitely* sensitive to bright light in the middle of the night and wee hours of morning. In fact, our ipRGCs and SCN become increasingly responsive to light with every hour after sundown.[68] If you're wondering if fireplaces, campfires, candlelight, or moonlight are too bright to view after dark, the answer is no. Firelight sources emit very long wavelengths, and moonlight is low lux. Candlelight is typically just 1 lux. A bright, full moon is *less* than 1 lux! Compare those numbers to a typical table lamp, which is 200 to 400 lux, or commonly used overhead indoor LED lighting, which is 500 to 1,000 lux.

So are we to all avoid artificial lighting and opt for candlelight or moonlight?

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Maybe, but more on that later. In the meantime, let's acknowledge that most people just won't do that, and even if we opt to at home, we can't control the lighting of most other environments like office cubicles, restaurants, hotels, and the rest.

That is where this protocol can help. Viewing sunlight in the afternoon reduces the sensitivity of neural circuits in your retinas, so that any artificial light you see after dark does not have as strong an effect in disrupting melatonin and other circadian-related molecules and processes in your eyes and brain. This protocol is especially important if your mornings and days are mostly spent under artificial indoor lights, as that will cause any artificial lights you view at night to have an outsized negative effect on your sleep and circadian rhythms.[69] Think of viewing the sunset as your (partial!) nighttime TV-watching or phone-scrolling inoculation. That said, you should still strive to dim the lights in the evening, and make it as dark as possible while you sleep, as discussed in the next protocol.

COMMON QUESTIONS:

What if I can't get myself to a place where I can see sunlight in the late afternoon or early evening?

I understand. Most of us are working, driving, or otherwise occupied indoors when the sun is setting—especially in the fall and winter months. And while sunsets are both beautiful and beneficial, telling your boss "I need to leave to go watch the sunset" is not going to go over well. (Although saying "Let's go watch the sunset together because it's good for our health" might be a good idea, depending on how you frame the question.) If you can't watch the sunset, just try to go outside at some point in the afternoon to get some ambient daylight in your eyes before dark, even if it's just for a stroll around the block, or a few moments on a balcony. Do whatever you can. The ambient light will still serve your SCN, and thus your circadian rhythm, sleep, and health, in numerous beneficial ways.

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SLEEP PROTOCOL

3

Avoid Viewing Bright Lights in the Final Hour Before Bedtime

WHAT TO DO:

- **After sundown, limit your nighttime light exposure.** You have a few options for how to do that. Which you use will depend on where you are and what activities you need to carry out.
  - **Option 1: Dim the lights.** After sundown, dim the lights in your home or wherever you are in the hours before sleep.
  - **Option 2: Use red lights at night.** I am a fan of using soft amber or red incandescent (or even amber or red LED lights, which are easier to find nowadays) for indoor lighting after dark as they don't spike cortisol or suppress melatonin as much as many bright white LED lights do.[70] Remember, you want to try to keep your cortisol low in the late evening and especially the final few hours before your bedtime at night. You also want your melatonin elevated then. While this protocol might seem extreme, shifting to amber or red lighting in the final hours before sleep can make a marked difference for some people's ability to fall and stay deeply asleep, which extends to every aspect of next-day energy, mood, and focus.[71]
    - *Consider buying a few high-quality red light bulbs.* Bon Charge makes great LED bulbs that are just the right level of brightness to see, but not so bright as to disrupt circadian rhythms and Ra

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Optics has LED bulbs that lack the usual flicker of LEDs and can shift between daytime and "candlelight" mode (I have no affiliation with Bon Charge or Ra Optics, but I use these brands at home, and I travel with one or two of their bulbs when on the road and staying in hotels.) SaunaSpace makes a large, red incandescent bulb that is about the size of a shoebox that can illuminate a medium-sized room. I have one in my living room and another in my bedroom. Incandescent bulbs give off a softer illumination than LED ones, and have some known advantages for mitochondrial health, which I cover in chapter 5.

- *Consider small, portable side table LED lamps or bulbs that can be flipped from bright white to yellow to red, depending on the time of day or night.* Bon Charge makes these. They are great if you need to navigate to the bathroom at night. They charge off your computer or a wall outlet and (hooray) don't require Wi-Fi or an app. I know many people who have solved their "I wake up in the middle of the night to go to the bathroom and then can't fall back asleep" issues by switching to these.

Note: *I am not talking about "red light therapy," and you don't need a fancy red-light panel for this protocol. In fact, red-light panels tend to be very bright—exactly the opposite of what you want to use at night! They have their place, which I will discuss later in this book.*

- **Option 3: Use combination UV, blue, and green light blocking glasses after sundown.** This is the most versatile and cost-effective option. Consider buying a pair of blue and green light blocking glasses if you need to be on a computer, look at a phone, or watch TV at night. They are also helpful when you can't control the lighting because you're out at a restaurant, in an airport, et cetera, at night.

  I helped design ROKA Wind Down glasses, which block the full

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range of blue and green light, are lightweight, and come in a variety of frames. They are excellent quality.

- **Option 4: Use good ol' candlelight.** Just make sure to blow it out before you go to sleep!

HOW IT WORKS:

Humans are not the strongest or fastest creatures on earth, but we are the best at building technologies. Every technology—the automobile, the smartphone, airplanes, antibiotics—brings the potential for unprecedented power over nature in our daily lives. Artificial lights have vanquished darkness. But in the case of LED lights, in particular, this technology also carries a risk to our circadian cycle, our mitochondria, and thus, our health.

Until about ten years ago, most artificial lighting used incandescent bulbs, which contain more long-wavelength light and a more even distribution of different wavelengths than LED bulbs. Incandescent bulbs have been largely phased out because they are less energy efficient than LED bulbs. Nowadays, most indoor lighting comes from LEDs, which emit a disproportionate amount of short-wavelength light that can potently reduce melatonin levels.[72] Emerging evidence also points to negative effects of LEDs on mitochondrial health (which we'll go into later, in chapter 5).[73]

Those are some of the risks. Now let me explain why bright artificial light at night may also be affecting our mood. Each of us has a brain structure called the habenula that sits at the middle and top part of an egg-shaped brain structure called the thalamus.[74] Your thalamus is a station for routing different types of sensory and motor information to the correct parts of your brain so you can detect and integrate that information into your thoughts and actions. When I was an undergraduate and graduate student taking neuroanatomy, the habenula was listed as having an "unknown function." Recent studies in rodents, fish, and humans finally revealed what it does.[75]

We now know the habenula is part of a network that controls depressive

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feelings and disappointment.[76] Habenula activation creates those states by altering dopamine and serotonin dynamics in brain areas associated with reward.[77] Why would we harbor such a structure and circuit? The answer is that not all behaviors are meant to be rewarded. Some need to be punished so we are less likely to repeat them. And it turns out that viewing bright light in the "you really should be asleep now" phase of your circadian cycle is one of them. Animal studies and emerging evidence in humans show that viewing bright lights at night causes your ipRGCs to activate a specific region called the perihabenula.[78] That leads to elevated levels of cortisol, reductions in dopamine, next-day anxiety, and deficits in learning—all consequences that appear to be separate from any reductions in total sleep time.[79]

For most people, the "you really should be asleep now" time is somewhere between the hours of 11:00 p.m. and 4:00 a.m. But of course, neither your SCN nor your habenula knows clock time; they only know circadian time, which follows the circadian body temperature, cortisol, and other twenty-four-hour rhythms I described briefly earlier in this chapter. Your body temperature starts to rise in the final two hours before waking, and continues to rise throughout your morning and day until you reach the mid to late afternoon.[80] At that point, it starts to decline. That decline continues as we sleep, reaching its lowest point, called, unimaginatively, your *temperature minimum time* about two to three hours prior to waking.[81] So when I say avoid viewing bright lights from LEDs or other sources at night, I am referring to the time about six to eight hours before your temperature minimum time. This may seem overly technical, but knowing your temperature minimum time can be very valuable. And no, you don't have to measure your body temperature; your temperature minimum is the approximate time in your twenty-four-hour circadian cycle that roughly corresponds to two hours before you typically wake up, alarm clock or no. The exact clock time of course will vary depending on whether you are a morning lark or a night owl, or somewhere in between (more on how to determine that soon). But since most people wake

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