Welcome to the Huberman Lab Podcast where we discuss science and science-based tools for everyday life.
I'm Andrew Huberman and I'm a professor of neurobiology and ophthalmology at Stanford School of Medicine.
Today my guest is Dr. Jeffrey Goldberg.
Dr. Jeffrey Goldberg is the chair of the Department of Ophthalmology at Stanford University School of Medicine.
He is a clinician, an MD or medical doctor who sees patients every week, as well as a PhD,
meaning a laboratory scientist who directs his own laboratory focused on understanding the mechanisms
and cures for diseases of the eye and vision such as glaucoma, retinitis, pigmentosa, and macular degeneration.
Indeed, Dr. Goldberg is one of the world leaders in developing methods to cure blindness.
He is also intensely knowledgeable about all things related to vision.
During today's discussion, we indeed cover most all of visual and eye health.
You will learn, for instance, about the benefits as well as drawbacks of wearing corrective lenses, such as contact lenses or eyeglasses for reading.
You will learn about the benefits and detriments of sunlight, meaning how it can help your vision, in fact, how it can help reverse or prevent myopia, nearsightedness,
as well as the things to be cautious about with respect to sunlight in terms of development of cataracts,
which are occlusions that prevent vision.
We also discuss many tools for maintaining and improving vision across the lifespan, ranging from behavioral tools,
so specific vision tasks and exercises for the eye that you can do that are known to improve or maintain your vision,
as well as specific surgical procedures such as Lasik surgery.
We get into all the details of, for instance, how often to do these various eye exercises,
how long the benefits are maintained, as well as age-related considerations for things like Lasik eye surgery.
We even get into how to best clean your contact lenses, whether or not to use disposable contact lenses or other forms of contact lenses.
We also discuss things like dry eye and the best remedies for dry eye.
And we talk about the scientific and clinical data around nutritional approaches and supplementation-based approaches for maintaining and improving vision.
So whether or not you suffer from floaters or dry eye, or you're considering changing your eye prescription,
or you have concerns about whether or not relying on corrective lenses is impairing your vision and you want to enhance your vision,
or if you're somebody who has perfect vision, today's episode is going to include science and protocols that will be highly relevant to you.
I should also add that if you are somebody who suffers from or who has family members who suffer from diseases of the eye that can impact vision,

such as glaucoma, retinitis pigmentosa, and macular degeneration,
we also delve deep into the discussion about the most advanced technologies for preventing and offsetting vision loss due to those diseases as well.
Thanks to Dr. Goldberg's incredible knowledge, his clarity of communication, and his generosity with that knowledge.
By the end of today's episode, you will be armed with all of the modern information you need in order to best maintain and improve your eye and vision health.
Before we begin, I'd like to emphasize that this podcast is separate from my teaching and research roles at Stanford.
It is, however, part of my desire and effort to bring zero cost to consumer information about science and science-related tools to the general public.
In keeping with that theme, I'd like to thank the sponsors of today's podcast.
Our first sponsor is Maui Nui Venison. Maui Nui Venison is the most nutrient-dense and delicious red meat available.
I've talked before on this podcast about the key importance of striving to get one gram of protein per pound of body weight.
Now, when one strives to do that, it's also important to maximize the quality protein to calorie ratio.
In other words, you don't want to consume a lot of extra calories in order to get your quality protein.
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Again, that's MauiNuiVenison.com slash Huberman to get 20% off.
Today's episode is also brought to us by Element.
Element is an electrolyte drink that has everything you need.
That is the electrolytes, sodium, magnesium and potassium, but nothing you don't, which means no sugar.
It's critical that we get electrolytes because every cell of our body, but in particular our nerve cells, our neurons,
rely on electrolytes in order to function properly.
With Element, it's very easy to ingest the correct ratios of electrolytes.
They come in these little packets. They're really delicious.
You mix them up with anywhere from 8 to 16 to 32 ounces of fluid.
I like mine pretty concentrated, so I'll drink a 16 ounce glass of water with Element in it.
When I first wake up, I'll also consume another one of those, maybe 32 ounces with one packet.
When I exercise and maybe another one, if I happen to sweat a lot during exercise,
or if I was in the sauna and sweating a lot, if it's a very hot day, et cetera.
If you'd like to try Element, go to drinkelement.
That's lmnt.com slash Huberman to claim a free Element sample pack with your purchase.

Again, that's drinkelement.lmnt.com slash Huberman.
Today's episode is also brought to us by 8Sleep.
8Sleep makes smart mattress covers with cooling, heating and sleep tracking capacity.
There's absolutely no question that sleep is the foundation of mental health, physical health and performance.
When we're sleeping well and we're sleeping long enough, everything in our daily life goes that much better.
A key component to getting a great night's sleep is the temperature of your sleeping environment.
That's because in order to fall and stay deeply asleep, your core body temperature actually has to drop by about one to three degrees.
Conversely, in order to wake up feeling refreshed, your core body temperature has to increase by about one to three degrees.
With 8Sleep mattress covers, you can cool or heat your mattress at the beginning, middle and end of your night in order to optimize your night's sleep.
I started sleeping on an 8Sleep mattress cover about two years ago and it has dramatically improved the sleep that I get each and every night.
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8Sleep currently ships in the USA, Canada, UK, select countries in the EU and Australia.
Again, that's 8Sleep.com slash Huberman.
And now for my discussion with Dr. Jeffrey Goldberg.
Dr. Jeffrey Goldberg, welcome.
Thanks, it's great to be here.
You and I go way back.
We will spare people the discussion about all of that, but I'm really excited for today's discussion because I get a tremendous number of questions about vision and eye health.
And of course, as a neuroscientist who has worked on the visual system, I sometimes have answers or partial answers, but more often than not, I don't have the answers.
And yet I'm confident that you do or that if you don't, you can direct us to the proper place to get those answers.
So to kick things off, I want to ask you what was one of the most commonly asked questions when I solicited for questions in anticipation of this episode, which is how early should one do an eye exam on their child and how regularly should we all be doing eye exams?
Also, is the fact that I think I can see normally confirmation that I can see as well as I think I can.
So that's really three questions, but baby comes out, do they check their eyes right away?
And so how and how often should they check and what kind of information is there?
Yeah, that's a great question.
It's obviously something that touches us all.
So the answer to that really differs a little bit at the different stages of life.
First of all, every baby gets an eye exam or should be getting an eye exam.
And one of the main things that you really just are screening for right when that baby is born right in the nursery right in those first few days is to just look for a red reflex.
You know, when you take a camera picture, a flash picture, and sometimes you get red eye, that's

actually the light from the flashes, you know, reflecting against the retina and coming back out of your eye.
It looks red.
And a red reflex is actually very normal.
That's great.
And if you have one of a number of diseases in the eye that can present even in babies, even in newborn babies, including most concerning, but thankfully least common retinoblastoma, which is the most common pediatric eye cancer, which again, thankfully is quite rare.
Those babies won't have a red reflex in that eye.
It's going to be kind of a whitish or gray reflex.
And so even just that first little, you know, doctors taking the little pen light and even just flashing it in the in the baby's eyes.
So that's, that's, that's our first eye exam.
And hopefully we've all had that and hopefully every baby being born today is getting that getting that first eye exam is really just looking for that red reflex.
It's not typical as long as that's looking good to worry about getting an eye exam from there, kind of through childhood, like maybe early elementary school, unless your baby is presenting with one of a number of features that parents often pick up on.
For example, as the baby's aging through those first couple of years, you know, through the first couple of years, babies actually don't have great visual acuity.
And so as they're aging over those first couple of years, it's normal for them to have, you know, roving eye movements, for example, be searching their environment.
But over those first couple of years, if parents start noticing the baby isn't, you know, isn't making eye contact or looking where a sound is.
Certainly if they have what's called my stagmus, like these rapid flickering, alternating eye movements, anything like that, of course, you're going to trigger trigger an eye exam.
But otherwise, most babies, other than their pediatrician doing that red reflex check when they're in for their regular well child checks, that's really all that's needed through that.
When most kids get to elementary school age, they'll often be often done at the schools and amblyopia screening exam.
If kids eyes either if one eye doesn't see that well, like maybe you're very near sighted or far sighted in one eye and pretty normal sighted in the other or the two refractive errors are quite different from each other.
That can lead to a condition you've talked about on the podcast before called amblyopia, which is probably one of the more common or most common eye diseases of children.
Or if the eyes aren't aligned, you know, our eye muscles and the brain behind them are really responsible for keeping the two eyes looking straight ahead.
And if that's not working properly and one eye is off kilter and therefore the image of what we're looking at is falling on different spots of the retina, it's not syncing upright in the brain.
That can lead to this disease condition called amblyopia, where that eye is no longer talking to the brain properly.
And there's a pretty easy screening exam that can be done for strabismus, the misalignment of the eyes that kids will do in elementary school.

The other main presenting symptom of kids in elementary school is when they admit to their parents, I can't see the board or I can't see the teacher up front and then they might be quite near sighted.
And so that will also trigger an exam.
And so those are usually the parts for babies, for toddlers, for children, school aged children that might reasonably trigger an exam.
A couple of questions about early eye exams and we'll get on to eye exams and older individuals in a second.
But I want to interrupt you with this question.
So you mentioned that, you know, there can be a misalignment of the eyes.
I've seen many people's babies where there is one eyeball that seems to be kind of drifting around and then it might correct.
But sometimes they'll have a, we don't want to get technical here for our listeners, we'll keep it general.
But either convergent eyes or one eye converging cross-eyes or wall-eyed, you know, again, using that non-technical language here.
And my understanding is that the brain is taking that information in and is very plastic.
It's changing at these early stages of development and that it's fairly critical to get that stuff corrected early on because if you wait too long, the brain can essentially become blind to the, or rather,
the brain cannot learn to handle the proper alignment.
So in other words, if a kid has cross-eyes, crossed eyes, excuse me, and they're not corrected until their 20s, it's possible that they will never recover normal vision.
Whereas if you recover, if you align the eyes properly early in development, they can indeed recover vision.
How early can and should one consider getting those eye realignments done?
Yeah, yeah, pretty much right on.
What they'll do is if they detect any eye misalignment and sometimes parents are good at noticing that.
Sometimes you take a picture and one eye got the red eye reflex and the other one didn't.
And sometimes people notice that their kid's eyes are sort of turning in.
It seems like too much.
Sometimes there's what's called pseudo-strabismus, which is where actually, depending on your anatomy, if you have a little extra skin sort of on the inside corners of your eyes,
it makes your eyes look turned in when actually they're straight.
But if your eyes are actually turned in or slightly less common in children or common in adults misalignment turned out, it's really important to correct that early.
And the reason is, as you were saying, the brain starts ignoring it.
It fails to fully develop the strong connections for the data coming in from one of those two eyes into the brain.
And if you pass certain sort of thresholds during development, during childhood, without correcting that connectivity, getting those two eyes to work together properly,
you can permanently lose that.

And so we used to use very sort of gross numbers like it's fully correctable if you can intervene before age three.
It's partly correctable if you can intervene before age six.
You got a chance before age nine.
But it turns out and follow on studies that even kids into their young teens have a shot at correcting that eye brain connection, that amblyopia, that loss of vision that can occur during early development.
So even if you're only, you know, unfortunately detecting that later on in childhood or even sort of the tween years or early teen years,
it's still worth a try to really push to retrain the weaker eye and then also realign the muscles so that they can work together to keep the eyes focused.
I'll tell you, it's interesting and there's a lot more to learn about brain plasticity and probably a lot of really cool new therapies yet to discover that could reopen what's called critical period plasticity.
This plasticity that we have during development that kind of goes away as we age.
And that critical period plasticity is, you know, has been the best studied actually in the visual system.
And the idea that we could reopen that is really fantastic.
But for different parts of that eye brain connection, there's different periods for critical period plasticity.
For example, even if you get the amblyopic eye to see well again and then you realign the eyes and now they're working together.
A lot of kids will never recover full depth perception, stereopsis, the use of two eyes to see depth, for example.
So why that part of the brain doesn't correct as well as the visual acuity or central vision part of the brain?
I'm not sure if we understand that yet.
I'm going to ask for a curbside consult as sometimes called right now by telling you a story.
When I was a kid, I went swimming without goggles and I had one eye closed and the other eye open and closing as it went in and out of the water
because I'm a deficient swimmer and I only breathe to one side unless I've really consciously forced myself to breathe to both sides in a freestyle swim.
Got out of the pool and I was seeing double.
It was pretty eerie and then it became downright scary because I didn't recover my double vision until they patched one of the eyes forcing me to use the other eye that had been closed the entire time.
And fortunately, this was done early enough and I was young enough that within I think it was about a day or so I restored what normal vision.
However, my depth perception is terrible.
I'm the kid that, you know, fly ball was hit to me in the outfield and it's coming and then it hit me.
This is why I've generally focused on foot sports throughout my entire life as opposed to, you know, precise hand-eye coordination.
I'm better at throwing darts and things with one eye closed than I ever would be with both eyes.
Maybe that's true for most people.

Question I have is, is it true that even just a few hours of misalignment of information to the two eyes early in development
can permanently rewire the brain unless there are some corrective measures such as patching up one eye?
And the example I gave is just one.
But for instance, if, you know, someone injures, you know, gets a scratch on their cornea and they patch the eye and the person happens to be 10 years old,
is it important to then patch the other healthy eye after the, you know, the scratched eye is feeling better?
In other words, how critical is it to ensure the balance of information coming into the two eyes even on the order of hours or days?
Yeah.
Your story is, it has some features of, you know, totally usual how we think about misaligned eyes leading to amblyopia where one eye is weaker,
patching the strong eyes so the weak eye can recover, but not necessarily fully regaining depth perception.
And so that part of it is, you know, quite stereotypical.
The part of your story that's atypical is that for most kids, an hour or two, let alone minutes, an hour or two, even an hour or two a day,
if you were, I don't know, if you were a young kid and you just really were training up on throwing darts and you were just keeping one eye closed to throw the darts,
you know, really practicing for an hour a day.
It'd be very unusual for that to trigger this kind of either strabismus, misalignment of the eyes, let alone amblyopia.
And the strabismus is what's giving you the double vision because they're misaligned, let alone the amblyopia of one eye turning out weaker.
If I had to guess, of course, not having, you know, done your exam before that fateful day in the swimming pool,
if I had to guess, I would guess that you may have had some intermittent strabismus and your brain was already getting kind of hit.
And you, neither you nor your parents may have even noticed it.
It could be happening, you know, at other times a day or you're not kind of really paying attention.
It doesn't kind of stand out in the way that that day that you got out of the swimming pool, you really noticed it.
And it may not have been that strong.
It may have been quite intermittent.
But if you had had some years of intermittent esotropia or turning in of the eyes or exotropia turning out of the eyes,
that just happened here and there, but was accumulating sort of damage or failure to connect over years leading up to that day in the swimming pool.
And that day just tipped you over the edge.
And you've got double vision.
You really noticed that that led to an eye exam at an eye care provider.

And they said, wait a second, this size stronger, this size weaker, you've got a little amblyopia.
You want to start patching your strong eyes so you can get your weak eye back.
So for 99.9% of the kids who like, you know, yeah, they get a little corneal scratch or they're patching when I closed or, or, you know, anything that's sort of a rare event like that.
Nothing to worry about parents don't have to worry.
Kids can be kids.
They can play.
They can do that kind of thing and not have to worry.
And it's unfortunate that we can't tell in advance which kids been having the intermittent amblyopia.
Because we don't do a standard eye exam on every five year old who's not complaining of anything.
But, but yeah, so that's an, that's an unusual case in yours.
And if I had to guess, I would bet that you were having some sort of subclinical, untracked, uncharted, unnoticed, maybe strabismus leading up to that point.
Okay, great.
Thank you.
You can send me a bill at the end.
Along those lines, I'm 47 years old.
So I was part of the generation that grew up with some computers in the classroom, but not a lot.
Nowadays, kids from a very young age are looking at iPads and phones and screens and things very close up.
And there is a wealth of experimental animal data showing that if you limit vision to just close range, that the eyeball lengthens.
And therefore the visual image falls in front of and not directly onto the neural retina, the essentially the light sensing portion of the, of the eye.
And those animals become myopic or nearsighted.
What can we say about the environmental conditions in which kids are seen from the time they're born through, let's say, adolescence in their teen years in terms of how their visual system wires up?
And are there any recommendations that are coming from the scientific literature, clinical studies, clinical trials, excuse me, or otherwise that indicate what a healthy visual environment consists of?
Yeah, yeah.
That's a great question. And actually, it's really relevant these days because, you know, myopia is so common.
It's more common in Asian populations. You know, it's called an epidemic in China.
In California, we have a lot of Asian heritage or Asian Americans. And so we see a lot like at Stanford, we see a lot of, you know, myopia in kids and adults, and really starting to get thoughtful on the science of myopia control.
How do we, how do we provide the right environments?
Now, what's interesting is that for decades, the assumption, some of the data really led us to the path of thinking like, gosh, the more you spend at near activities.
And these are mouse model experiments like you described, but also well-designed human cohort studies, you know, figuring out like asking, you know, kids and families, like, how long is your kid reading or in front of the computer?
How myopic are they? How nearsighted are they versus how much time is your kid in front of the

computer doing near work? How myopic or nearsighted are they?
And these well-designed cohort studies did point towards this concept that if you do too much near work as a kid, that you're more likely to develop nearsightedness as you get through those, those sort of, you know, preteen and even into the teen years,
which is when most of that myopia progression or eyeball elongation is actually happening to cause nearsightedness.
It's only been in the last few years that some really exciting studies have actually pointed in a slightly different direction.
And that's that maybe it's not all, not to say it's not about near activity, but maybe it's not all about near activity.
Maybe it's actually a little more about the kind of light we're getting into our eyes.
And I think you've talked about this before, and it's really important when they've now studied and asked the kids instead of just how much near and how much far are you doing?
How much time are you spending indoors in indoor lighting, which doesn't have full spectrum light in a typical indoor environment, versus how much time are you spending outdoors playing in the yard?
You could be reading outside, but what kind of time are you spending outside?
And, and of course, when you're outside in sunlight, even it's a direct sunlight, you're getting a different spectrum of kind of full spectrum lighting from the sun.
And it looks like it's pretty clear now, actually, that it has maybe more to do with outdoor lighting time than just near work.
And so I think that, you know, we've, we've actually already seen the first couple randomized controlled trials where they're having kids intentionally spending time outdoors versus sort of standard life, which, you know, is going to be often much more indoor time.
And, and seeing some effects, you follow those kids over a couple of years.
And the kids who spend time outdoors are progressing in their nearsightedness less, like their, their nearsighted prescription is not getting as strong as the kids who are spending more time indoors.
And there's some pretty good biology that's getting worked out, going back to animal models more about, about how that might be working in the retina in this inside the eye.
But it's pretty compelling concept.
And so, you know, as a parent, you may want to be, you may want to be telling your kid like, okay, yeah, I want you to read that book or, you know, if your kids plan on the phone or something like that or the iPad or something like that, they're allowed that time.
Okay, you can have that time, but I want you to spend some of the time that you're doing that outdoors.
Are there any thresholds for the amount of time that one would suggest their child be outdoors to get that full spectrum light?
It's a great question.
You know, we talk about cohort studies where we just ask people, what are they doing?
And there seems to be, you know, a little bit of what we would call a dose dependent response.
Maybe the more time outdoors might be better.
We don't know if there's an upper limit like, gosh, if you go over two or three hours, there's no additional benefit.

Talk about that in cohort studies.
The real gold standard for answering these kinds of questions are randomized controlled trials and specifically placebo controlled or a control group that's not getting the intervention.
That's our highest level of evidence for clinical evidence for any of this kind of science when we're talking about humans or preclinical models in the laboratory.
And the study that hasn't been done yet to really answer that question is to randomize kids to telling this group of kids, you just do your normal life.
Tell this group of kids, we want you outside an hour.
This group of kids, we want you outside two hours a day.
This group of kids, three hours a day.
And see between the groups, is there a big difference?
We have pretty good evidence now from the studies that have been done that the difference between zero and one or two hours is clearly there.
Is five minutes enough?
Is five hours better?
I don't think we know the answers to those questions yet.
Like what's the right dose?
But there's probably at least some dose dependence to that.
And I can imagine it's a little bit hard to tease apart the near far viewing from the indoor outdoor because yes, of course, a child could be outside on an iPad up close.
But it's hard to imagine that at some point they aren't seeing off into the distance far viewing as it's called.
And the reverse is also true.
If you're indoors, unless you live in a very, very large home or you're staring off a balcony, far viewing is much harder to achieve.
And perhaps it isn't important to isolate these variables, although I can see the challenge in developing a really good clinical trial, randomized clinical trial for this.
Meanwhile, I'll go into the grave shouting or saying rather and suggesting that people get some morning sunlight in their eyes to set their circadian rhythm.
But far viewing at least a few minutes and ideally hours per day or a mixture of near and far viewing by being outdoors just seems like a good thing to do regardless of age.
So are there any data in older people?
Not necessarily elderly, but older people.
So people in there from say 25 years of age into their 60s or 70s that getting outdoors and getting this full spectrum light is healthy for the eye in ways that are separate from the known healthy effects of doing that on circadian rhythm setting.
Yeah.
Yeah.
The circadian parts pretty clear.
And most patient and most people, the development of nearsightedness happens a lot until age 10, little more through age 20, little more than that into the, you know, in through the 20s up to 30, tiny bit in the 30s up to 40.
But usually by those later ages, your prescription might be changing a quarter of a diopter.

That's the measurement that we use when we, you know, give you your glasses prescription, a quarter of a diopter, half a diopter.
It could get a half diopter more nearsighted or less nearsighted, you know, once you're aging into your 40s, 50s and beyond.
So most of the action on nearsightedness development is actually really happening in the younger ages.
So again, the premise of intervening in an older person, and I'll just include you and me and older people for the sake of this definition as much as I'm reticent to do that in general.
I think the premise of sort of light modulation for nearsightedness in older people is probably not so strong.
I think there are a lot of other benefits.
You've talked a lot about circadian rhythm.
There's so many health benefits to exercise and, you know, if you're getting outdoors, there's a good chance you're going to be walking or bicycling, you know.
So exercise value for the health of our eyes and the rest of our body is clearly there.
But I don't know that there's really a strong premise that you're going to change your glasses prescription, you know, in our 40s or 50s or beyond.
I'd like to take a quick break and acknowledge one of our sponsors, Athletic Greens.
Now called AG1 is a vitamin mineral probiotic drink that covers all of your foundational nutritional needs.
I've been taking Athletic Greens since 2012, so I'm delighted that they're sponsoring the podcast.
The reason I started taking Athletic Greens and the reason I still take Athletic Greens once or usually twice a day is that it gets to be the probiotics that I need for gut health.
Our gut is very important.
We're populated by gut microbiota that communicate with the brain, the immune system and basically all the biological systems of our body to strongly impact our immediate and long-term health.
And those probiotics and Athletic Greens are optimal and vital for microbiotic health.
In addition, Athletic Greens contains a number of adaptogens, vitamins and minerals that make sure that all of my foundational nutritional needs are met and it tastes great.
If you'd like to try Athletic Greens, you can go to athleticgreens.com slash huberman and they'll give you five free travel packs that make it really easy to mix up Athletic Greens while you're on the road in the car on the plane, etc.
And they'll give you a year supply of vitamin D3K2.
Again, that's athleticgreens.com slash huberman to get the five free travel packs and the year supply of vitamin D3K2.
It's probably worth touching on some of the dos and some of the don'ts for eye health generally.
And then I promise I'm going to get us back to adult eye exams because I have a lot of questions about that.
I can imagine that it's probably not a great idea to be exposed to extremely bright light and this is why people who weld wear eye shields.
But of course, most people are not welding.
Other sorts of environmental conditions are detrimental to our vision health across the lifespan,

including brightness of light.
We talked a little bit about near far.
Obviously, we want to keep toxins and acids and solvents and things out of the eye.
But what do you see?
Hopefully not commonly, but what are some of the things that you feel might not be discussed enough in terms of eye health?
You know, I think at all ages, eye safety is something that we don't talk about enough.
You know, our eyes are delicate.
The front surface of the eye, the cornea, the clear window that lets the light go into your eye.
That's a delicate, very sensitive structure.
It's thin, maybe a millimeter at the thickest half millimeter in the center of our eye.
The retina is it's neural tissue.
This is like really an outgrowth of the brain.
This is very sensitive.
It's subject to degenerative disease and injury.
Our eyes, even if they just get hit, can get very inflamed.
Our eyes can be more inflammatory than a bruise on our skin on our shoulder might be.
So eye safety is a big one and people who are working in certain industries, you know, anyone who's doing any metal grinding, people who are even just gardening.
If you're doing some significant gardening and cutting and you could, you know, fleck a little bit of dirt.
There's a lot of, for example, fungus that lives in the ground, natural stuff.
It's all very normal in the earth.
But our eyes aren't really made to absorb that fungus and have a piece of dirt kind of stick in our eye like that.
And so people are at risk, I think, for, you know, for not.
And we see too much kind of really unnecessary eye injury, eye trauma that if people wore either their glasses because they happen to wear prescription glasses or goggles or for more advanced work, you know, safety goggles.
Of course, if you're sanding, doing wood shop projects, anything like that, sawing, including, you know, again, in the garden cutting things.
You know, I think eye safety, you know, eye trauma is a big one.
And, you know, we probably see one or two, what we call open globes a week come into the emergency room.
And, you know, those are tough because, you know, again, the eye is delicate and it can do a lot of healing, but not infinite, right?
And so we really, you know, that's one that I think is really an untapped opportunity is just a little more education around eye protection, protecting against eye trauma.
What about eye cleanliness?
There's some pretty dramatic videos also.
I've put some of these on my Instagram handle.
These are MRIs of people rubbing their eyeballs and people really getting a sense of, first of all, a restatement of what you said, getting a real sense of just how much the eyes are an outgrowth of the

brain because of the one you see with the optic nerves and all their beauty.
And the eyeballs moving around as someone rubs their eyes.
I have to imagine that rubbing the eyeballs a little bit isn't bad, but actually called you.
I don't know if you remember when I was a junior professor, I woke up from an app one day and I couldn't see how to one eye.
I was freaking out.
So of course I called you and I had pressure blinded myself by falling asleep on my hand or something like that.
And you assured me that my vision would come back and indeed it did.
So you played dual role of ophthalmologist and psychiatrist.
Thank you.
And indeed I can see out both eyes now.
But rubbing our eyes, getting gunk in our eyes, you know, I think unless somebody has lost their vision temporarily, it's hard to imagine this is like a problem.
It's a big deal.
But when it happens, it is truly frightening.
We're so dependent on vision.
So, you know, what are your recommendations about rubbing or not rubbing eyeballs about hand washing and cleanliness?
And also, how do you wash an eye properly?
Do you use soap and flush it with water?
Do you just flush it with water?
Or should you not even do that?
Should you use saline?
And you realize these might sound like low level questions, but these are the things that people deal with on an all too frequent basis.
So for most people, most of the time, actually the eyes are a very good clean environment and actually our tears contain enzymes that help break down bacteria and bacterial toxins.
And so for most people, regular eye washing doesn't have to be any part of their standard routine.
In terms of the surface of the eye, the part of your eye, the conjunctiva, over the whites of the eyes, underneath the eyelids, anything underneath the eyelids, it's pretty self cleaning.
And actually our tear production and blinking is very good at keeping our eyes clean.
The eyelids, eyelashes can be another story.
And especially as we age, we can, you know, like our skin is breaking down a little differently than when we were younger.
You can develop what we sort of nicknamed scurf, which is like kind of little dead skin bits that accumulate around the eyelashes.
A lot of people develop what we call blepharitis, which is just just means inflammation of the eyelashes.
Yeah. And for that, doing some eye scrubs is a good idea.
They actually sell little pads that you can buy kind of a little that you rip open and you can use to kind of lightly clean the eyelashes.
But you can also just use like a no more tears baby shampoo, just pump a little bit into the palm of

your hand once or twice a day.
Let a little dilute it with a little water and under the sink and either with your finger or an edge of a washcloth.
Just very lightly rub the eyelashes.
What I like to do with the eyes closed with the eyes closed and don't scrunch them closed too tight because you're actually burying the eyelashes when you do the roots of the eyelashes when you really scrunch close.
So just gently close your eyes, just, you know, real gentle closure and then just lightly scrub it shouldn't be abrasive.
You're not trying to exfoliate the eyelids or eyelashes in any way.
Just lightly rub with that kind of dilute no more tears baby shampoo and that can really help people with their eye comfort.
If you feel like you've got something in your eye, your ideal eye wash is actually going to be a sterile saline solution, a salt water solution that, you know, they sell little bottles over the counter eye wash solutions like that.
A lot of people wear contacts will have that kind of eye wash solution just a sterile saline eye wash.
Just pure salt water doesn't have to have any other chemicals or preservatives in it.
You can of course use not actual sea water or salt water.
Not salt water.
Thank you.
Yeah, not salt water out of your salt pool, not salt water out of the ocean, but like a saline salt water that's available in a sterile.
Now you can also just use artificial teardrops and some of those come in non preservatives.
Some of those come in preserved versions.
Those are all also completely safe to use in the eye.
And there you can, you know, you can sort of spritz into your eye, you know, hold the lid open and give it a little spritz.
If you feel like you've got something in your eye, a piece of dirt or a lash that's not coming out just to rinse it.
But but having like a regular routine, you know, you're not going to hurt anything with the occasional eye rubbing.
We all do these things just kind of as a, you know, even a nervous habit or just absentmindedly, you know, you might, you know, scratch your arm or rub your eyes or things like that.
That's fine.
You're not going to hurt anything.
There are conditions where people sort of develop kind of a almost like a psychological habit.
There are certain conditions where people actually do too much eye rubbing.
It can be dangerous if you're in that group, but for the regular run of the mill, every day occasional eye rubbing fine.
If you certainly if you get a lash in there and you're trying to rub it and blink it and tear it out.
And again, in that situation, you can use some artificial tears, wedding drops, saline drops.
Those would be the way to do it.
What an incredible tissue.

The way you describe it, you know, the self cleaning and yet so delicate.
A piece of the brain literally lining the back of each of our eyes like like a pie crust.
I mean, it's a really remarkable biological system.
Of course, I don't have to tell you that.
It's just it never ceases to to amaze me.
Let's talk about eye exams in adults.
So people are aware, presumably that they're optometrists and ophthalmologists.
I think it's important that we define their different and also overlapping roles.
And for those that, you know, are past high school age, probably not getting eye exams unless they're sensing a problem.
Perhaps not even with blurry vision or difficulty seeing at a distance,
but sometimes just what feels like fatigue of the eyes or a hard time maintaining alignment of the eyes.
So how often do you recommend people get eye exams?
What is a true regular eye exam?
And is it important that people go to an ophthalmologist or will an optometrist suffice?
Typically, optometrists are a little bit easier for most people to access
because there's usually one someplace near an eyeglass store.
So what are their roles? How often should we get our eyes checked?
Yeah, optometrists and ophthalmologists do have very overlapping roles in being eye care providers.
There are something over 40 or 50,000 optometrists in the United States.
There's somewhere around 20,000 ophthalmologists in the United States.
Optometrists get an optometry degree.
They often have OD after their name.
Ophthalmologists usually went to medical schools.
They either have an MD after their name or they kind of a DO version of a medical degree.
And then optometrists will have done additional clinical training in their area of eye care provision.
Ophthalmologists, MD, doctor, ophthalmologists, eye care providers,
in addition to that training will have done surgical training in ophthalmology.
Now, there's a lot of overlap and in both scenarios,
you can be getting your sort of general exam taken care of, maybe a screening exam.
I think that there's been a traditional differentiation between optometrists and ophthalmologists with optometrists providing a little more of the primary care eye screening,
maybe managing early disease, common diseases as well,
with more advanced disease often sort of upgrading to perhaps specialist ophthalmologists in those areas.
But that distinction has been declining over time.
It's still true that in, I think most if not all states, only the MD ophthalmologists surgeons can do eye surgeries.
But both groups of eye care providers can diagnose,
both can prescribe appropriate eye drop treatments including prescription eye drop treatments for many of our diseases, eye diseases.
And in some states, optometrists have successfully lobbied for sort of expanded rights of providing

eye care.
And again, access to care for the regular person wherever they may live is the most important element.
And so being able to access eye care, whether it's with an optometrist in your community or an ophthalmologist that may be in your community
or maybe at a distance, I think that's the really important thing is to access care.
Now, kind of like we were talking about with kids, if you're in your teens, 20s, maybe even 30s, and not having any problem, you've got no complaints, you can see a distance, you can see it near.
So you can read without glasses, you can drive without glasses.
You're not having any eye pains, pains around the eyes, redness of the eyes.
You may never present to an eye care provider through the first four decades of life.
And almost all the time, it's going to be okay, right?
If you're not symptomatic, the chance you've got some terrible lurking disease in there is low.
But we do wish that we had a little more screening going on because there are some diseases.
Glaucoma, for example, my specialty, the two main risk factors for glaucoma are increasing age.
And it usually presents, in most cases, actually after age 40, but also increasing eye pressure.
And if your eye pressure is too high, you can't feel that.
That won't feel funny to you if it sort of slowly is crept up over the years.
And so from a screening perspective, it is good to get some kind of screening exam,
could be at a public health fair, could be that you go into the local optometrist,
just say, hey, I've never been checked, I'd like to be checked once, make sure everything's good.
Could you ask, sorry to interrupt, but could somebody say, I'd like my pressures checked?
As I recall at the optometrist, they're going to do a puff test.
So they're going to blast some air, get a sense of how rigid or soft.
Again, using non-clinical, non-technical language here.
The eyeball happens to be.
Right now, by the way, I'm sure there are several hundreds of thousands of people
who are with eyes closed, touching the sides of their eyeballs.
And I'm only half joking. Please don't do this, folks.
Given the conversation we just had about eye cleanliness and eye rubbing.
My understanding is that the truly old fashioned eye pressure exam,
was you would close your eyes and the ophthalmologist would gently press
to see whether or not your eyes were more rigid than last time.
Is that right?
Yeah, that's called belotment.
And you can kind of, you can kind of just take one second if you're listening
and press on your eyes just very lightly.
And there's a little give, of course, the eyelids part of that give,
but it's not like rock hard.
And if we press and it feels under the eyelid like gosh,
something under there is rock hard, then we know something is wrong.
That is way too high pressure if it's rock hard.
But I'll tell you our ability to differentiate the fine points of eye pressure

other than rock hard or not rock hard is pretty limited.
So yeah, the optometrist office or the ophthalmologist office
as part of a comprehensive screening exam, they'll check the eye pressure.
They'll look at the surface of your eyes,
make sure everything's looking healthy there, including the eyelids and lashes.
And they'll look inside the eye and be able to screen for these diseases that way too.
In addition to checking if you're complaining of any, you know, blurriness at distance or at near.
Now, after age 40 or so, a lot of people will present to an eye care provider
because we all get what's called presbyopia.
And presbyopia just translates to disease, a vision of the agent.
So, you know, myopia is our word for nearsighted, hyperopia is farsighted.
Actually, emitropia means normal sighted.
So I can see at distance without any glasses, I'm emitropic.
But then we all get presbyopia.
And as we age, the lens inside our eye that's helping focus light onto our retina gets stiffer.
Such that our eye muscles are no longer able to relax and reshape that lens.
And we're not as good as we age at moving our focus from distance vision.
Distance vision, by the way, is basically anything three feet or further away.
You're basically viewing light rays coming from infinity at once you're past three feet.
So three feet or further, being able to focus that into 14 inches or 12 inches,
which might be a normal comfortable reading space for you.
We lose that ability to flex our lens, relax our lens, refocus our lens from distance to near.
And most people around age 40, could be a couple years before,
could be five or 10 years later that you notice it.
But sort of around that time, you start needing reading glasses.
You need a little extra, even if you can see finite distance
and don't need prescription glasses for distance,
you need a booster, you need reading glasses for near.
I don't know if you're experiencing this yet.
Yeah, I'm really intrigued by this, but maybe you could clarify.
When you say reading glasses, do you mean just a magnifier?
Because I use a 0.5 or a 0.75 magnifier for reading,
but I try and rely on them as little as possible.
And I want to get to this about using glasses as a crutch and the problems with that.
I have a story about that too.
It's no coincidence I decided to work on vision.
I mean, after all, I had a bunch of vision issues that fortunately are corrected.
But I do experience, for instance, when I wake up in the morning,
if I look at my phone, which by the way, folks,
I try and get outside and see some light first before ever looking at the phone.
But I'll notice when I first look at my phone in the morning,
that I can see it very clearly through my right eye,
but that if I cover my right eye, my left eye is extremely blurry

to the point where I'm calling Jeff, you know, I'm afraid.
But then over the course of maybe 10, 15 minutes, it resolves.
And I don't think it's because something's in my eye.
I don't think it's pressure of having slept on that side.
I don't think it's a lubrication of the eye issue.
But the two eyes seem to come into focus, so to speak, at different rates early in the day.
And if I pop my readers on, I can see right away.
So I will use readers late in the day often if I want to read at night or something like that.
So it just, it feels so much more relaxing.
I feel like I can finally relax, whereas otherwise I realize that I'm straining in order to see.
Is there any clinical data in what I just described?
Yeah.
You know, Andy, I'll tell you my story that's like that.
And we were living down in San Diego when you and I were both professors at UC San Diego.
And we had moved into a house and I found a pair of glasses, a pair of reading glasses in a closet.
And, you know, we asked around, you know, did any of the grandparents leave some glasses behind?
Nobody seemed to know who they were.
So we finally just decided like, well, I guess the people who moved out of the house just left a pair of glasses, you know, in the back of this closet.
And then I tried the glasses on and I looked at my phone up close and was just like, oh my God, wait a second.
I didn't realize how blurry my near vision was.
And this is back, I was about 40, 42, something like that.
So, so I didn't even realize until I put on the readers.
And these were, you know, 1.25 magnifiers, you know, so also mild, mild ones.
Yeah.
And then I'll tell you, I got addicted because who doesn't like good vision, right?
I mean, oh my God, now I can make the type smaller on my phone.
I can, you know, it was wonderful.
And you can relax a bit.
I mean, the musculature that's responsible for moving the lens and focusing the eye and then all this extraocular musculature.
I mean, we forgot, I mean, I'm definitely going crow's feet around my eyes, probably because I, you know, squint or something.
You know, just the ability to relax one's face.
It just feels like, you know, more, more energy, I feel like can be devoted to what we're actually looking at.
Yeah.
Not making light of this.
Yeah.
Well, pretty soon I just kept that one pair of glasses with me all the time and I would just keep them in a pocket and whip them out whenever I was, you know, working at near using my phone.
At a little greater distance, like a typical computer distance, I could still see the computer fine.

So it really started for like kind of that close up phone.
It was, it was, I could get into here, but not all the way into here.
And yeah, and then pretty soon I was just totally addicted.
And so, you know, then I had to go buy 10 pairs and leave them one by the bedside table, you know, one in the car, one in the computer bag, one on every desk I work at.
Yeah.
Because I'd leave them anywhere and forget them.
Yeah, exactly.
You know, yeah.
So, yeah, so whether using the readers accelerates the progression of dependence on the readers is still not, you know, that's still up for debate.
You know, some studies say maybe yes, some studies say maybe no.
But certainly psychologically, we get addicted to good, easy vision.
And if you don't have to squint and you're, if you're not straining your muscles and all of a sudden the text on your phone looks crisper again.
Boy, that's addictive.
You're going to like good vision.
And so it feels like you're getting dependent and how much of that is changing the eye muscles and how much of that is just the psychology of wanting to have good vision.
I think probably the jury's a little bit out on that point, but point being, either way, your dependence will grow.
And as you continue to age, 40s, 50s, up until about 60, 65, the ability to shape that lens gets weaker and weaker and weaker.
And so you need to move from the 0.5s to the 1.0s to the 1.5s.
To the Coke bottle.
Well, thankfully not.
You eventually max out at about plus 2.5 or plus three, because that's the amount of extra refractive power that you need in magnifiers to take the equivalent of your infinity viewing and bring it up to 14 inches to read it near.
Basically, you need a plus three and then you don't need any lens eye muscle action whatsoever.
So you kind of max out around 2.5s or 3s.
So because most people will hit this somewhere in their 40s, this sort of like, gosh, I'm having trouble on the phone.
I think most people actually use that.
That's like kind of the first time for a lot of people.
They're like, well, I guess I should go to the eye office, right?
See the optometrist or maybe ophthalmologist.
And when they go in, they should be getting the standard in either of those offices will be to give you a full screening exam, including maybe it's the puff test or a blue light test or a little pen that can check your eye pressure and having a look inside and seeing if you're retina and optic nerve look healthy.
It's kind of screening for all the main diseases.
And so and they'll tell you at that point, hey, you'll look great.

If you feel like your glasses aren't doing it for you in a year or three years, come back or they might say, hey, I've detected something.
I'm worried about you and they'll set up a routine for your ongoing eye care.
Assuming that somebody doesn't have, you know, some form of amblyopia or the need for some really robust, corrective lenses.
And they are already using readers, let's say a plus one or so, you know, plus one, plus or minus point five reader.
Would you recommend based on my experience and based on your experience that people strive to avoid using them for as long as they can?
Because in some sense, if that's the recommendation, then the recommendation is that people kind of deal with the fact that they're seeing a little less well or a lot less well than they possibly could.
So I'm assuming that people can still drive well, people can still read, but it involves a little bit more effort.
In other words, are we weakening our eyes by using these readers?
I realize you said that the data are a little bit mixed, but as long as one can perform their required daily activities, would we be better off delaying the use of readers?
There's two important answers to that question.
One is regarding the lens and the eye muscles that control the lens.
And it's entirely plausible.
That's what I was saying, kind of the data is mixed on, but it's plausible that if we would just exercise, like work a little harder, kind of not use as strong a reader as we want or not use that reader as often as we might really enjoy.
Are we exercising those muscles and kind of exercising the ability to stretch versus relax the lens and kind of slow the progression from the 1.0 reader to the 1.25 reader to the 1.5 reader, et cetera, right?
And so that's what I was saying, the data is mixed, but there's a good premise that maybe if you're exercising.
But let me give you the on on the other hand, it's probably ideal to give your retina and your brain the sharpest visual signals you can.
So why hamstring your retina and your brain and your vision and your enjoyment and ability to read or do near work by constantly undercutting the reading glasses or leaving them out or you're not helping the whole back part of yours.
Maybe you're maybe you're helping the lens, but you're definitely not helping your retina and brain by feeding it blurry information all of that time.
So I actually think just give in, use the readers, have your, enjoy your best vision all the time.
And if that means wearing glasses, and by the way, if that means that you're going to have minus two glasses for vision and you'll eventually need minus two fifties for distance vision, or if you're going to need readers, 1.5 readers now and in a few years 2.0 readers.
Okay, so you'll get the next reader.
It's it's actually not a big deal.
You can you can, you know, you're not, you're not hurting.
You're probably helping.
And in the meantime, it's an enormous enjoyment to actually have good vision all the time.

Right.
So, so I actually counsel people just wear the glasses that work best for you.
You know, you're only minimally changing how your prescription is going to change over time, very minimally.
So just enjoy your best vision, even if it's using readers for clothes or prescription glasses for far.
I appreciate that recommendation.
I do enjoy using the readers at night.
It really helps for all the reasons I mentioned before.
I've noticed that driving at night presents an enormous strain on my visual system.
And I've noticed this for a number of years.
Are there any, I know there's something called stationary night blindness.
I don't think I'm stationary night blind.
I think the mutation for stationary night blindness was identified in the Calusa horse or something like that.
These were horses that you could walk up to very easily and they wouldn't even see you until you were right there.
Someone's going to correct me on this.
It's the internet.
But I think that the mutation was identified, et cetera.
But I don't think I'm stationary night blind, but I do find that driving at night, I get very fatigued.
And then I'll sometimes even wear my plus one readers when I drive at night, which removes the fatigue, even though I'm looking more or less at a distance.
Are there some conditions that make it hard for people to see at night for which they would want corrective lenses?
And what sorts of biology underlies that assuming that somebody is not stationary night blind or a Calusa, I think is the name of the breed horse?
Yeah, that's a great question.
You know, we, for the optical defects in our eyes, most or many of which can be corrected with just having the right prescription lenses.
We can get away with it without using those corrections in brighter light.
And so during the daytime, you know, you could be slightly blurry.
You know, if I have a real bright light and a good high contrast book, you know, with black letters on the white page, I can get away with reading that without my readers.
Unlike if I'm in dim light, then I feel and that might be kind of what you're describing.
If you're reading at night, you actually prefer to use the readers a little more even at night because we can make up for a lot of that blur.
If we just have bright enough signal and contrast coming into our eyes.
Makes sense.
Yeah.
So when you're driving at night and noticing this, this might be revealing a little bit of a need for glasses.
I'm not suggesting this is the answer, but far more common than having congenital stationary night blindness would be being what's called a latent hyper rope.

Okay.
Now we talked about already how the lens inside our eye goes from focusing at distance to then we squeeze the muscles, the lens actually rounds up and it allows us to focus it near.
Some people's optical system of their eye is actually wired or designed or sort of set up in length, not for regular distance, which would be anywhere from about three feet to infinity.
But it's actually designed, it's actually tuned for being beyond infinity, which doesn't make any actual sense when you talk about it, but just the optics of the eye at their best focus are actually focusing the light behind the retina.
And, and if you're doing that when you're younger, you're actually using some of your focusing power to use those muscles, strain those muscles, relax that lens, round up that lens and have your vision focus from beyond infinity to normal distance,
like distance vision.
And so if you're a latent hyper rope, you are constantly using those muscles.
And again, if you're tired, it's the end of the day, your muscles are feeling a little fatigued.
Your latent hyperopia, or by the way, if you've had a drink or two, alcohol can do this too, your latent hyperopia can kind of kick in, especially as we're age and we're not as good at refocusing that lens anyway.
And now all of a sudden your vision is kind of reverting to its natural state, which is slightly out of focus at distance, because it's actually focused beyond infinity, if you will.
And so all of a sudden you put on that plus one just for a little extra booster kick and you're like, oh yeah, yeah, distance vision is clean and easy now.
So I'll have to bring you into the clinic to really be sure, but you could be exhibiting a little bit of that kind of latent hyperopia.
I definitely want the eye exam and I want it from you and I've been called a lot of things in life and we can now add perhaps latent hyperopia to that.
I'd like to take a quick break and thank our sponsor, Inside Tracker.
Inside Tracker is a personalized nutrition platform that analyzes data from your blood and DNA to help you better understand your body and help you reach your health goals.
I've long been a believer in getting regular blood work done for the simple reason that many of the factors that impact your immediate and long-term health can only be assessed with a quality blood test.
The problem with a lot of blood and DNA tests out there, however, is that they'll give you information about certain lipid markers or hormone markers, but no information about what to do with all of that data.
Inside Tracker makes it very easy to look at your levels of hormones, metabolic factors, lipids, etc.
And then to assess what sorts of behavioral nutritional supplementation or perhaps other interventions you might want to use to bring those numbers into the ranges that are appropriate and indeed optimal for you.
If you'd like to try Inside Tracker, you can visit insidetracker.com slash Huberman and get 20% off any of Inside Tracker's plans.
That's insidetracker.com slash Huberman to get 20% off.
And again, this discussion is not designed to be an eye exam for me, but I have yet another experience that I think illustrates the key importance of both critical period plasticity and the

questions about whether or not to rely on corrective lenses.
And that is, from the time I was pretty young, I could make my sister laugh by deviating one eye inward, so not crossing my eyes, but moving one eye inward.
And then what happened was when I was in college and studying a lot, a lot and getting very fatigued, I noticed that this eye started to just kind of drift in a little bit.
So I went to the campus health center and they gave me a prescription for a prism lens, which of course redirects the image.
But then I noticed that this eyeball moving inward, and I guess for those of you watching on YouTube and not just listening, I can do this by just moving one eye in.
Yeah, it's a fairly pronounced. It started to really drift in at a relaxation state, and I started seeing double again.
So I thought, whoa, this one prism lens is a crutch of the sort that I really don't want. Crushed the glasses, broke them, and it never went back to them.
I have voluntary control over it, but that's one example where the corrective lens can actually create a pretty significant shift in eye position if one relies on it.
So this gets back to this issue of when should people force themselves to work with their natural vision, maybe do some more far viewing and certainly get outside and get sunlight into the sunlight, full-spectrum light, as opposed to relying on corrective lenses.
Yeah, and you've raised a very important distinction here, and that's the distinction between the muscles that are inside our eye that we use to relax and refocus the lens.
And the muscles that are on the outside of the eyeball, of course, inside our orbit, but on the outside of the eyeball that turn the eyes.
And if everything's working right, keeps our eyes really straight.
And we talked about earlier this possibility that you may have been having a little bit of intermittent esotropia or intermittent turning in of the eyes that then culminated on that day at the pool when you really noticed it.
And your ongoing ability to actually turn one eye in could be related to that.
I remember as a kid standing in front of the mirror, and I couldn't get my eyes to cross, even though friends could do it.
So I was in the losing group on that end of the spectrum.
And you became an ophthalmologist.
And then I became an ophthalmologist.
And I must say, it is very reassuring that you have excellent vision.
I always worry when I go to a new dentist and I look up at them in one moment, and if they're not wearing a mask, that their teeth are not pristine.
I think, well, what am I doing here?
So an ophthalmologist with excellent vision brings me great comfort.
But cobbler's children should have shoes.
Right, exactly.
But yeah, so when to correct, when not to correct with lenses.
And I realize here we haven't talked at all about contacts.
We've been talking about eyeglasses.
Yeah, let's come to contacts in a sec if you want.

But yeah, let me return to your question.
The difference between providing corrective lenses that allow you to focus for near or distance in your glasses so that you can go easy on the inside the eye, eye muscle having to work so hard.
A lot of people get eye strain and sort of headaches even from that, from not having an adequate correction that they're wearing.
That's different actually, especially when we're children or again into that, maybe even into the teens and even young adult years.
From the eye muscles on the outside of the eyes, which are supposed to be yoking our eyes straight and so that you have them both looking at the same point in space.
And there it's actually quite a common treatment to try to under correct and ask people to exercise and not just give a prism that says, hey, if your eyes in sometime we'll use a prism so the light sort of looks right to you.
But rather under correct that and sort of really force you to exercise trying to yoke your two eyes straight together.
And so that's that's in contrast and they're actually, I think many optometrists who often specialize in what are the right glasses to give in a situation like that.
Wherever possible, especially during development as our bodies are developing as we're sort of growing in our younger years.
Take the approach of intentionally trying to under correct, not use a prism or not use a full prism correction and to really help.
Sometimes it's also like an accommodative reflex that your eyes are just you're spending so much time reading it near.
When you read it near your eyes actually naturally turn in a little bit to focus at that near so that they can be looking at the same word on the page.
And that can also if you've got kind of too much muscle drive you can overshoot that.
And so sometimes just using not a prism but like a little bit of a plus lens in kids just so they don't have to work quite so hard to turn their eyes in and sort of over exercise those muscles.
These are all great examples where going to an eye care provider often for these kinds of issues and optometrist is the right first place to start.
You'd like to say that every optometrist and every ophthalmologist is always going to give the exact right thing for for each kid or young adult or older adult to do and and we wish all medical care providers were were always right on target and a lot of times it's a perfect science but a lot of times it's an imperfect science and so it could be that at least with
you know we're now 2025 30 years later but like it could be that today that 20 year old version of yourself would have been given a different approach to having one eye intermittently occasionally turning in like that.
Is there any real value to near far exercises you know so called pencil push ups or a smooth pursuit tracking. I've talked a little bit about it before on the podcast but those you know some time ago so what are your thoughts on on that.
Is there any value whatsoever I mean they require a little bit of work just like going to the gym but you know 25 reps a day of near far, especially as one is transitioning from age 30 to age 50.
Is it worthwhile. Yeah. Is it harmful in any way. Definitely not harmful and again you know would it slow down or sort of slow down your progression to presby opioid or needing those reading glasses

could be some people also develop
sort of you know a real failure to properly turn their eyes in and so they actually would benefit if you've been diagnosed with that inability you're having double vision at near but not at distance. So that kind of convergence insufficiency for example then then pencil push ups often get prescribed as a way to try to exercise those skills and you know in your eye muscles.
I should interrupt here and just tell people for those of you there listening not watching the pencil push up we can put a link to it in the show note captions but it's essentially taking a pen or pencil looking at it at at arms distance and then slowly moving it toward your nose and deliberately working hard and it is a bit of effort to continue to focus on it at a close distance at some
point it will become blurry because I can't cross my eyes any further unless I become a Cyclops and then moving it back out again and doing that for you know 10 to 25 repetitions maybe once or twice a day a few times a week.
That's what those are pencil push ups. Yeah. Yeah. So you're certainly not going to hurt anything. There are other situations where those really do get prescribed and there's definitely some good clinical trial data suggesting that they can actually help for example recovery from
concussion. A lot of people actually one of the really telling ways to diagnose concussion and this can be concussion from sports or a fall or you know any any source of concussion your smooth pursuit which is the ability.
Let's say I've got a dot moving around in a circle on a screen and I'm following that thought with my eyes. My eyes should be able to very smoothly follow that circle around.
On one watching a hockey game. Is that like fan like that. You know just following a ball you know following any movement with smooth pursuits of your eyes and after concussion that actually those systems in our brain the sort of reflex of ability to properly
follow that use that visual input to tell your eye muscles exactly where to move gets disrupted and so all of a sudden your smooth pursuit starts to look choppy it's not so smooth anymore and it's actually a way to diagnose and follow recovery from concussion and part of the visual rehab sort of
neuro rehab one of the approaches being used and further studied still in recovery from concussion is actually doing those kinds of exercises like pencil push ups or basically what you've described is focusing from far away to focusing near and doing that back and forth and using that to sort of like help
regain the tighter control of our eye movements and that eye brain connection. So if traumatic brain injury causes deficits in smooth pursuit eye movements and some of the recovery protocols for traumatic brain injury are to have people do smooth pursuit protocols and pencil push ups.
Are these also the sorts of things that anyone can just do I mean whenever possible we like to share tools for various aspects of health on this podcast but of course we don't want people cowboying this stuff in a way that could be detrimental to their to their vision so is it okay to get on YouTube and find a smooth pursuit
tool we can put a link to these there there several of them and people spend a few minutes doing this. Yeah, you're definitely not going to hurt anything so totally fine to do it and some people may notice you know like they feel a little more visually active if they do these kinds of exercises.
I think most people would do them and not notice something in their daily life. We actually have made so much progress you know in research in thinking about how do we take the diseased or dysfunctioning or aging eye and get it back to healthy and normal.

But there's a whole other area of science that's we're really just barely touching we've actually we've actually just opened a vision performance center to really get at not just how do we rehab the sick eye back to health.
But what's the difference between functioning normally and functioning above normally. For example, athletes when they get studied for visual vision characteristics, they have faster visual reflexes, higher visual acuity, how much of that was, you know, genetic how much of that is trained. We don't really understand could we train all of us with, you know, normal vision to get up to supra normal vision. These are like great important questions that are really relevant to, you know, every regular person of course you know people doing e sports and the gaming communities and athletes as part of what we're
studying in the vision performance center but these are really, really big opportunities to try to understand how do we move people from normal vision to supra normal vision. And there's evidence that you can do it.
So here's a great example. Some athletes train using these special goggles that actually use electrical signals in the glasses part of the goggles to actually black out your vision.
One 30th of every second, two 30th of every second, three 30th of every second. Now imagine you and I are passing a basketball back and forth, except you're wearing goggles, and all of a sudden you're only getting 90% of the data of where's that basketball on its way to my hands.
Now you're only getting 80%. Now you're only getting 70% of that visual information, and you are practicing right you are getting good at catching a basketball when you only have a fraction of the visual information.
And now I put you back on the basketball court without the goggles. You might be really good at passing that basketball around and catching that basketball right. And so the idea that we could train and understand the biology of training to get the eyes from normal to supra normal performance.
I think it's an amazing area and one that we've really just started to dig into.
That's fantastic. So this is a new program at Stanford through the Department of Ophthalmology. Is it linked up at all with the WUSI Performance Institute?
Yeah, actually there's been a lot of focus over the years I think in human performance and there's actually a new human performance alliance and center.
We've long had really run through the Department of Orthopedics, a human performance laboratory that's really much more about joints and muscles and strength and conditioning and stretching to layer on to that now a real understanding of how vision is operating.
You know, it's interesting. Let's go back to the example of concussion. You know, we've got, I don't know, about 800 varsity student athletes in all the different sports at Stanford.
And you might have a student athlete come in and say, you know, something doesn't feel right. I got a little hit on the head. I feel like my vision is a little bit messed up. Maybe I've got a mild concussion.
You could imagine doing some of these tests on some of these performance athletes, for example, and saying, well, gosh, you look normal.
But actually they used to be operating at a super normal rate and this is a noticeable decrement for them.
And so just starting to study and understand what's the difference between normal and super

normal. How do we go back and forth between those two? How do we measure that difference? And maybe ultimately, how do we train into that difference? I think it's going to be exciting. And not just for athletes, you know, for regular people, you know, you talk about driving at night.
Is there a solution where we could train our eyes to be better at driving at night? And I don't know, maybe reduce the number of accidents that happen out in the world.
Well, certainly there's physical training protocols which are redefining what a 60 year old or a 70 year old could look like and feel like and be able to perform like.
Why not do the same for vision? So I don't think there's anything supernatural or greedy about doing it. I think that's the excitement of biology and neuroplasticity that you can extend it forward as opposed to just trying to wire up correctly during development.
This is a perfect time for me to ask you a question that I'd love a clear answer on if it's possible. It's not always possible, which is, could you define 2020 vision and a few of the variants so that any person could understand it?
So we think of 2020 as perfect vision. What does that mean? What would degraded vision look like? Whatever those numbers are. And then what would above normal, supra normal vision look like? And is it true that fighter pilots have supra normal vision?
Yeah, that's another population like many athletes of people who may have sort of better than normal vision.
2020, you know, we define almost everything we do based on, you know, kind of an average, not sick human being, adult, whatever it is, right? And so 2020 vision means that you can read the smallest letters at 20 feet away that the average healthy person can read at 20 feet away.
So you can read at 20, what they can read at 20. Okay. Now, if you have worse than 2020 vision, maybe you have 2025 vision, 2040 vision, maybe you have 2200 vision, which on the eye chart at the office is like the big E at the very top is 2200 vision.
That means you can read at 20 feet, what a normal person could read at 200 feet, right? So you've got pretty limited lower vision. We can measure down to like 2400, 2800. At that point, we're getting into like, gosh, can you count how many fingers I'm holding up, you know, that kind of thing.
And then ultimately, hand motion, can you even tell if my hand is moving in this side of your vision or this side of your vision? And then ultimately, after that light perception, can you tell if the room lights are on or off, right? And that's kind of the edge of being actually fully blind.
We call legal blindness in the United States typically 2200 or worse.
And is it true that there are people who are legally blind that are out there driving as we're having this conversation?
I have to imagine that that is unfortunately the case. But it shouldn't be because those people obviously are really severely impaired and that's obviously quite dangerous.
So that's 2020. Now, it gets worse, 2040, 2080, 2100. Can it get better? Yeah, it turns out that people can be sort of on the other end of that curve.
And so we could have athletes and fighter pilots, or people who have had Lasik surgery, who are 2015, 2010.
If you're 2010, that means you can see at 20 feet what the average person needs to be only 10 feet away to see, right?
And so you've got better than normal vision. And people do get to that through a variety of ways. And so it is possible to have better than 2020 vision.

Does the degree of visual acuity, because that's really what we're talking about here, differ dramatically between the two eyes?
In most healthy people, no. You know, remember, we talked about you're born with something like 2200 vision, takes you a couple of years, and it could be a little bit asymmetric.
2200 vision. Yeah, that reminds me, I've seen images of what babies can see.
You know, parents love looking at their child and thinking that their child is looking right back at them.
And indeed, often the child is looking right back at them. And your face to your child, sorry to break this to you folks, is incredibly blurry,
even at that close distance for probably the first six to eight months even before you come into sharp relief.
They're not seeing the fine details of your face. So smile big. That's right. Smile big. Keep those eyebrows dark.
Right. And keep cooing at them because they can hear pretty well.
That's right. Yeah, the optics of newborn babies are just dreadfully bad. Yeah. But they need visual stimulation.
Now, other species, you know, hawks, raptors, owls that hunt, they can naturally have 2010, 28 vision, right?
So much better vision. And that's just their normal vision as best as has been measured.
So there's definitely the potential for us to have better than 2020 vision.
Now, all of this we call visual acuity. And just to be clear for everyone, that's the vision in the very center of your vision,
like when you're reading or looking, that's the very center of your vision.
Our vision is actually described variably as a hill of vision. The peak is in the center.
That's, let's say 2020 in most people, right? But it's normal to have that slope off.
At our visual acuity, your ability to read the eye chart on the edges of your vision, if you can read the big E, that's pretty normal.
Like you would be 2200 out on the edges of your vision. And we would feel like, yep, that's pretty normal.
So our highest acuity vision is in the center. And that's a big part of why we spend a lot of time using those eye muscles to look around, right?
We got to get a little bit of a high acuity view of what's around us, fill in the gaps of what our brain is interpreting our peripheral world to look like.
It's almost like we have two visual systems. We have a high acuity, high pixel density camera in the middle, and then surrounding that is a pretty low resolution,
but very fast detector camera.
Yes.
You mentioned LASIK, but I want to make sure that before we talk about LASIK that we talk a little bit about contact lenses.
Is there any detriment to having a piece of glass or a piece of plastic on the front of your eye all the time?
And the reason I ask is not because I think we should live necessarily exactly like our ancestors, but it's a pretty bizarre adaptation to put a lens directly onto the front of the eye.

You have to imagine that the cells and tissues there are accustomed to getting a certain amount of oxygen.
They're accustomed to getting a certain amount of interaction with the environment.
And you're also now adding another surface the way that the tears are going to interact with the corny of the eye or probably change.
And who knows, maybe it doesn't make any negative difference at all.
But putting a contact lens on the front of the eye is about as close to putting a device on your brain as I can think of, except for maybe the cochlear implant.
Yeah.
That's a great question.
Now, first of all, I want to distinguish there are a few really medical uses for different kinds of contact lenses, like scleral contact lenses.
People have certain diseases.
There are other kinds.
But I think what we really want to talk about right now is just kind of the run of the mill.
I want to get my prescription taken care of, but instead of wearing glasses, I'm going to wear contacts.
Contacts, even the newest generation contacts, yes, they sort of changed the tear dynamics on the surface of your eye.
They decrease the oxygen diffusion that's just sort of out in the air onto the surface of our eye, onto the cells that are on the surface of our eye.
But most of us, especially as we're younger, have enough tear film reserve, enough oxygen reserve that we can easily tolerate these polymer gel soft contact lenses and wear them happily.
The advantage of contact lenses over glasses, purely from the perspective of correcting your vision, is that there's different elements of the shape of your eye that need to be corrected if you need corrective lenses.
And so for example, if the basketball shape of your eye is a little too steep or a little too shallow, that's what the standard glasses correct.
You may have been told that you have something called astigmatism.
That's where instead of having a basketball shaped eye, you have a slightly football shaped eye.
It's not round in the same dimensions on both axes.
And again, glasses can correct that.
But then there's higher order aberrations in our corneas and the clear window in the front of our eyes, or to some degree in the lens inside the eye that are focusing the light, that the glasses prescription can't correct.
But if you have a nice smooth contact lens on the front, it can correct.
So a lot of people wear glasses and contacts will report that they have a much higher quality of vision with their contact lens correction than with their glasses correction.
And again, in service of enjoying the best vision that you can enjoy in your daily life, that's an upside to seeing if contacts could work for you.
Now, there's another element though, and that's like, gosh, is there a risk of contact lenses?
And especially as we age, we have less tear film reserves, so contacts may become less tolerable as we age.

And the other thing is being really good about the cleaning because, you know, the contacts can trap bacteria or fungus.
And if you get a corneal infection from a contact lens, it actually can be quite devastating to your cornea.
Even if you successfully treat the infection, you can be left with some corneal scarring.
Thankfully, this happens very rarely.
But when it does happen, it can be quite difficult on the person thereafter to sort of suffer through having maybe a scar from that infection on the surface of their cornea that leads to some blurring vision, for example.
So we always recommend that if you're going to wear contacts, that you be really attentive to whether you're tolerating them well.
And then also to be really attentive to the recommended use and cleaning of the contact lenses.
I actually recommend that even though they're a little more expensive to afford, that people should almost always be just using the daily contact lenses that they don't have to clean or use for, you know, two weeks or four week period.
So these are disposable contact lenses?
Daily disposable.
And I hate to think of, you know, I don't know, filling our oceans or what have you with more polymer plastic, but at least the contact lenses are small.
And it's much safer for your eye to use a daily disposable than to use a two week or a four week and be responsible for the cleaning.
The other thing to be really responsible about is sleeping in them overnight because overnight when your eyelids are closed, of course, now you're getting even less oxygen to the surface of your eye.
Actually, most bacteria, especially many of the infectious bacteria to our bodies and to the surface of our eye are actually bacteria that don't really like oxygen.
And so we've got a low risk of getting bacterial infections on the surface of our eye.
But if we use contacts too much, don't clean them or sleep in them overnight when our eyelids are closed and now there's even less oxygen kind of helping keep the surface more, more clean, if you will.
That increases the risk a lot.
So being really good with the recommended use and cleaning of the contacts is critical considering daily use contacts.
You don't have to.
And look, most contacts are going to be the two week or four week kind where you put them in the cleaning solution overnight each time, give them a good rinse and put them back in the next day.
And again, most people 99.99 some percent of people are going to do just fine with that, follow the instructions and never get into trouble.
As we age, they're going to become less tolerable.
People are going to say, I used to wear my contacts for 12 hours.
Now my eyes feel really dry after six or eight or 10 hours.
Maybe some years after that, they say, gosh, I could barely use it for four hours.
I only use them when I go out on a Saturday night.
And that's OK.

You can back off as you need to back off.
But in the meantime, if it helps you, especially in the younger decades, if it helps you really enjoy your best vision, great.
What about UV protection in eyeglass lenses and or contacts?
I've dealt with many questions about blue light.
I am not somebody who believes that all blue light is terrible.
I think it's important to avoid bright lights of any wavelength late at night.
If you want your melatonin production to be normal and you want to sleep well, doesn't matter if you're wearing blue blockers or not.
If you're just underblastingly bright lights, it's going to suppress your melatonin.
And yet some people enjoy blue blockers for that reason.
Nowadays, a lot of people wear blue blocker glasses or blue blocking lenses or contacts throughout the entire day, thinking that blue light is bad for our eyes during the day.
I happen to subscribe to the idea that we want as much bright light as we safely can tolerate during the day, ideally from sunlight in order to set our circadian rhythm.
And yet a lot of eyeglasses and a lot of contact lenses out there have UVA and or UVB blocking features to them.
So what are your thoughts on this?
And I'm perfectly happy to be wrong and revise my stance on this.
What do you think about this UVAB blocking?
It's really important to distinguish that UV light on the light spectrum is right next to blue light.
Red lights on the other end, and of course infrared is beyond that.
And our eyes, other animals can see these, but our eyes can't see infrared.
That's why we call it beyond red.
And we can't see ultraviolet.
We call it beyond violet.
UV light is right next to blue light.
UV light is known to have a lot of adverse effects.
It's not really good for our skin.
And therefore, you know, we really want to avoid sunburn and kind of UV, you know, exposure and damage on our skin.
Similarly, it's not really good on our eyes and it affects both the ocular surface a little bit in terms of like kind of how dry or irritable your eyes might feel for some people.
And certainly over the long term, UV light will accelerate the formation of cataract, which is a blurring of an oxidative blurring of the lens inside the eye.
Profound UV light can be damaging to the retina if you're getting way too much on the inside.
So, so blocking UV light, I believe is just absolutely standard in every pair of eyeglasses.
And I don't know actually how much to what degree the different kinds of contact lenses also filter at least UV light.
Now blue blockers, blue blocking glasses is totally different.
And as I say, like I think almost all glasses because the plastics, almost all glasses are not made of glass anymore, they're made of plastics.
But I think almost all of them now filter the UV light, which again is like probably the safe move for

our eyes and periocular environment around the eye environment.
So blue blockers, you know, that's been a huge fan.
And I'll tell you the last three years through the pandemic, everybody getting on their computer hours in front of zoom meetings where we used to walk from building the building for a meeting, things like that.
I, you know, I remember, you know, like this sort of big uptick in these kinds of questions.
And I'm not sure that there's any data that blocking blue is helpful in any way.
And as you say, it may actually play into sort of circadian entrainment of our natural daily rhythm.
So, so I think blocking UV is a good idea.
And I think it's pretty standard.
You know, they make glasses by the way that actually react to UV light, they're called transitions, there may be a few different brands, I don't know.
But, but, you know, these are the sunglasses that are clear, except then they turn dark.
If you're out in the sunlight, and it's not just any sunlight, it's actually the UV wavelengths that that cause the chemical reaction in the glasses to turn from from clear see through to to sunglass blocked glasses.
And you may notice if you if any of you out there are using these kinds of glasses, that they don't work in the car.
You'll wear them in the car and they won't go to sunglasses, even though it's sunny out.
And again, that's because all standard car glass also filters UV.
That's why if you're riding around in the car and it's sunny out, you've got your hand, you know, up next to the window, wearing a t-shirt, you never get a sunburn through the car window anymore, because all our car glass is also filtering UV light for us.
So that's a very informative answer.
And before we started recording, you and I were discussing this practice of morning sunlight viewing, which again, I highly recommend over and over.
And you pointed out that low solar angle sunlight, so sunlight low in the sky viewed for maybe 10 minutes a morning and again, not forcing oneself to look at it and stare,
but blinking as needed is not going to cause extensive UV damage to the eyes.
It's really the when the sun is directly overhead that we're getting a lot of UV, which raises this other question, which is for people that don't wear corrective lenses and therefore are not blocking UV light to the eyes.
What should they do?
Are they in trouble?
Should they be wearing a brimmed hat?
Brimmed hat's a great idea that I'll get rid of a lot of the direct light into the eye.
Of course, you still have reflected light off of surfaces and that can include UV light, of course.
You know, wearing sunglasses outside, even if you don't have corrective lenses, you know, it may also be more comfortable to wear sunglasses outside.
So these are all fine.
You know, at the end of the day, it's probably not making a huge difference in the health of your eye, whether you've spent the last 50 years wearing sunglasses really dogmatically for your outdoor time or not.

You know, if you were going to develop, let's just say age related cataracts inside your eyes, which will all get cat...
If we all live to 120, we all get cataracts, you know, it's going to happen.
Some people younger, some people older.
Maybe if you were really dogmatic about wearing your UV blocking sunglasses, maybe you'd get your cataracts at 75 years old instead of 72 years old.
It may not be a huge difference in that regard.
So again, not something to be super stressed.
I think it's more a question of just, what are you comfortable in?
And then certainly I will say the other advantage of a wide-brin hat is it's keeping sun off of your face.
And these are the, you know, some of the, especially the upturned portions of your face, like the cheeks and the nose.
These are some of the most common places to get some of the skin cancers that you can get over a lifetime of sunlight exposure.
So, you know, the wide-brin hat, it's helping you for that as well.
Can't help but ask about comfort at varying levels of brightness.
I'm the person that when sitting in a cafe or something and on a bright day, I can be directly across from somebody like you,
who seems to be perfectly fine without sunglasses and maybe even were shaded under an umbrella or something of that sort.
And I'm squinting like crazy.
Is it normal for there to be a wide variation in sensitivity to light and does this have anything to do with the lightness or darkness of the eyes?
You have brown eyes, I have green eyes, but is there any real correlation there?
Yeah, you know, it's a good question.
I don't know if it's been formally studied, but I will tell you like I have the same impression you do, which is that if you have blue eyes or light-colored eyes that you're more likely to have more sensitivity.
We know that there's differences in the iris muscles that constrict and dilate in response to light.
For example, when you go into your eye care provider and they're going to do a dilated exam and they put the eye drops in your eye that dilate the eyes,
they sort of change the nerve impulses onto the iris muscles that the iris dilates and you get those big, big open eyes.
People with blue eyes, we absolutely know blue or hazel or light-colored eyes, you put that eye drop to dilate their eyes,
it's going to last four, six, eight hours, whereas in a brown-eyed person, often the dilation only lasts one, two, four hours.
So there's clearly biological differences between the irises and their muscles and maybe the nerves that feed those muscles,
between light-eyed people and darker-eyed people.
And that may also therefore relate to this differential sensitivity that some people have.
If you're not able to constrict your eyes in the bright light as effectively,

you're going to find that bright light more frustrating, more annoying, even painful.
People will feel like their eyes are cramping almost as they try to get those eye muscles to activate, to bring down the pupil and block some of that excess light from getting in.
Interesting.
Let's go back to Lasik.
What is Lasik and should I get Lasik eye surgery?
Does everyone need Lasik?
Can it make us super physiological?
Can it make me a 2010?
You know, often it can.
I'll just say that right up front.
It is amazing people will come out of Lasik surgery better than 2020.
But the cornea we talked about before, that's the clear window on the front of your eye, all the light has to get through there.
We talked about before already, like if your cornea is misshapen, if the basketball shape of it is too shallow or too steep,
then you're going to need glasses to see a distance and also at near.
If it's too football instead of basketball, then it's going to be what we call astigmatism.
And then you need a correction for that.
Instead of correcting with glasses that sort of help shape the light so it can go through your slightly off-shape cornea,
instead of wearing contact lenses, which also shape the light just as it's entering your cornea, right on the surface of the eye,
you can just reshape the cornea.
And the way Lasik does that, there's a few different versions of Lasik.
But basically the way the Lasik does that is it actually ablates or gets rid of a little ring or rim of that corneal tissue.
So that, for example, if you were a little shallow and you got rid of a little bit of that tissue around the edge with the laser,
Lasik starts with the word laser, if you got rid of that edge tissue, then you're sort of making it a little more basketball shaped, right?
Or if you were too steep on your cornea and you use the laser to kind of shave off a little bit of the tip of that basketball, right?
Then you're flattening it out, flattening out the cornea.
So it's that kind of reshaping.
And the technology has come so far that the Lasik procedures can actually correct not just the regular aberrations that we talked about,
but also some of these higher order aberrations.
And there are different monikers for this kind of Lasik.
It's all, I think, become fairly standard, but wavefront guided where it's actually using light waves to measure with a very exact localization exactly how much and where to laser for each individual eye to make that cornea past the light as ideally as possible.
Now, one or a few percent of patients will actually have a dry eye problem.

So after a Lasik, because it does interfere a little bit with those corneal nerves, for example.
And I do think that if you're a person who already has dry eye, hopefully if you're asking your eye surgeon about Lasik, hopefully you're being counseled that if you have dry eye, this might not be a good idea for you.
Just like contacts might not be a good idea for you if you already have a lot of dry eye.
But for a lot of people, especially a lot of younger people, it's quite common.
I think the statistics suggest maybe 15 or 20 percent of people who would benefit from Lasik, you know, who would otherwise be wearing glasses may get Lasik at some point in their life.
And, you know, I used to joke, you know, Lasik costs more money than a pair of glasses, but it doesn't cost more money than 10 pairs of prescription glasses over the course of a decade or two.
And so I used to joke that, gosh, if everyone had to have laser eye surgery for their best vision, and someone came along and said, hey, I've got an invention.
You don't have to have laser eye surgery anymore.
It rests on the ears and the bridge of your nose.
I call them glasses.
Could they have sold those for $1,000, $2,000 a pair?
I don't know, maybe.
But, you know, there's kind of a cultural element of saying, you know, like, I don't want to wear glasses.
You know, I'd love to be able to walk around without relying on glasses or contacts.
Of course, people who are very athletic or spending a lot of their time doing athletics, they may be quite irritated to have to deal with glasses or contacts.
People who have very severe prescriptions.
I mean, if you wake up and you can't even really, you know, you're fumbling for your glasses on the bedside table because you have such a strong prescription.
You can't even see what it says on the alarm clock next to the bed.
You know, these are all groups of patients who like really change their daily lives by getting out of glasses or contacts and taking advantage of LASIK.
And in, I don't know, 99% of the time, it's going to be like a safe, comfortable outcome for the patient.
Do they do LASIK on kids?
There are certain conditions, unusual corneal conditions where procedures like LASIK are used, but I believe it's ideal to not do it on children or even young teenagers.
And the reason goes back to what we were talking about before.
You are much more likely to change the shape of your eye and therefore the prescription you need and therefore what exactly the LASIK would laser while you're still in those growing years.
And you really want to be able to say, hey, my eyeglasses prescription has not changed in the last two or three or five years.
Because if you do LASIK and then your eye keeps changing shape, then by the next year, all of a sudden the LASIK is not doing, you're back in glasses again, right?
You can do a touch-up LASIK, do a little bit more, but it's generally, you know, you're going to be a happier person if you've reached that point in your life.
And maybe that's, maybe that's your late teens, more commonly it's into the 20s, where your eye has

stopped changing its prescription every year.
You've been steady and stable for some years and now you do the LASIK and it could easily last you a decade.
You mentioned dry eye.
A lot of questions about dry eye.
And a few years ago, I think you and I were at a meeting and someone who is very woven in with the companies that build and test drugs for different aspects of vision and health said, you know what?
The field really needs is a treatment that works for dry eye.
And I thought dry eye, like of all things, like why dry eye?
And then the more I learned about it, I realized that there are millions and millions of people that really suffer from dry eye and for whom standard drops are just not working.
So what underlies dry eye?
Is it some deficiency in the lacrimonial glands that produce tears for the eye?
And I think of tears is just kind of salty water.
And I wonder if they are more than that.
Is there an oil in there?
And if we know what's in tears, why can't somebody just manufacture something that works as well as tears?
Yeah.
You know, it turns out, you know, we've got a lot of other eye diseases, but by far the most common eye disease.
And I've been told by far the most common eye treatment, you know, purchased by anyone.
Now, granted, it's almost always over the counter.
Things like artificial tears is for dry eye.
And in part, that's because as we age, our tear quantity goes down and our tear quality goes down.
And so what do those two mean?
We have two different major elements to tears.
And as you alluded to, one is the salt water part of the tears.
And those are made primarily by the lacrimal gland.
And there's a steady drip of those tears onto the ocular surface as well as reflexive tearing, right?
If you get an eyelash in your eye or you cry, your lacrimal gland will actually squeeze out extra salt water tears onto the surface of the eye.
And so that's where most of the sort of wet part is coming from.
But there's also essential oils, critical oils.
These come from other types of glands, including glands in our eyelids called my bomean glands.
And the oils form a surface over the salt water part of the tear film and also intermix into the tears.
And as we age, we go down in the quantity of both salt water part of our tears and oil part of our tears,
but also the quality.
And in particular, the oil parts can often be seen to be going down more quickly.
The eye drop industry has pretty much solved for replacing the salt water part of your tears, right?
You can get either bottles of preservative containing, you know, you could use that bottle all month or for a month or two.

Or you can buy these strips of preservative-free artificial tears, which are really basically like the salt water component.
And you can use those preservative-free ones.
We have patients using them every hour if they need to, right?
You're not going to hurt anything with preservative-free artificial tears.
You just drop them in.
Just drop them in, yeah.
Either eye as often as you want or need when you feel it.
It's exacerbated in the world we live in, especially these days.
Now, with more time on computer, it turns out that when you read, including when we maybe used to read more books than we do now,
but also read on the computer or stare at the computer screen or work on the computer or actually just even watch the TV,
done very careful studies, you blink less when you're doing any of those activities.
And when you blink less, you're redistributing the tears less effectively.
And you're squeezing out less of the tears, including less of the oils as effectively as you could be when you're blinking.
And so between aging, tear quality, tear quantity, a lot of our activities, we're kind of in this losing proposition.
Now, I mentioned that we're pretty good at replacing the wet, salty part of our tears, but actually as an industry,
we haven't really figured out, A, how to really effectively replace the oily part.
And the oils do a few things, including when you have a layer of oil on top of a layer of water, the water's less likely to evaporate.
And so the oils help hold the tears on the surface of your eye.
And so if we're not making as many or as good oils as part of our tear film, that's also like kind of working against the saltwater part of our tears.
So yeah, as an industry, as a community, we haven't really figured out how to get the oil part solved for either by effectively replacing the oils
or treating our eyelids in a way, kind of rejuvenating those oil glands, getting them to kind of go back to their youthful state again.
So the eyes, including the eyelids and the oil glands, unfortunately, they're aging just like the rest of our body.
So this is one of the major features is dry eye and it's tough on patients because you feel it.
It's really tough because you feel it.
I have yet another experience to report where when I had the blepharitis, which fortunately was transient, I also experienced that every time I blink, I could feel the blink.
And boy, I'll tell you, we all, most of us take for granted what a pleasure it is to not observe the blinking of our eyes.
Because for those, I think in the last about two weeks, every time I blink, I'd feel an almost sandpaper like experience.
It wasn't particularly painful, but it was very uncomfortable because you suddenly conscious of every blink, and it's very distracting.

Now that resolved when the blepharitis resolved.
But I can't even imagine what it would be like to deal with that all day long, every day, really dreadful.
Yes, it really is.
And so you're absolutely right.
It's a very, it's one of our really big unmet needs.
And although for most people with dry eye, it can be managed with just the regular over the counter artificial teardrops.
You can buy at the grocery store or over the counter at the pharmacy for a subset of people who have really much more severe symptoms with the dry eye.
It's really, it's hard.
It's a really hard thing to have to live with all the time.
And we counsel on the use of tears.
We counsel on the use of eyelid cleaning like we talked about before where you take either these eyelid scrubs or a little dilute baby shampoo.
To keep those eyelashes really clean.
That keeps those oil glands functioning at their top capacity for you so that you're maximizing, you know, high quality to your production.
Reducing inflammation is also important, whether that's inflammation from allergy.
And of course, a lot of people's dry eye gets much worse in the spring with seasonal allergies when pollen is around.
If you have dust allergies in your home, that worsens your symptomatic dry eye.
Or other forms of inflammation.
There's a, there's an element of dry eye that we actually think is inflammation kind of working against our tear glands.
And, and in fact, some of the prescription drops now to help combat more severe dry eye are anti inflammatory or even low dose steroid types of eye drops.
So I think these are all sort of next generation treatments.
I think at the, at the really leading edge of next generation treatment is trying to better understand the nerves on the cornea and ocular surface.
And if there are ways that we could better treat them and help, help regenerate and rejuvenate kind of how the nerves and the, and the tissue cells are interacting underneath that tear film.
And that's where for some patients, we can actually use either, for example, blood serum.
Your blood serum is actually very rich in growth factors.
And many of those growth factors, it turns out empirically are really helpful for people with dry eye.
So if you're one of those people who's been really struggling with, with dry eye, you might ask your eye care provider, hey, I heard about serum tears.
Is that something that could help me?
Serum tears.
So is this PRP? Is this platelet rich plasma?
Related, but, but not the platelet rich portion, at least not yet.
They can draw your blood, spin out all the cells, you're left with the kind of liquid part of your blood.
That's the serum.

And then they can dilute that with some salt water, maybe with some preservatives in some cases.
You could keep it in your freezer, thaw out the bottle when you're ready to use it, you know, each few weeks.
And, and then use it just like an eyedropper bottle.
And those serum tears actually can be very helpful for people with, with much more advanced or severe, hard to control dry eye symptoms.
Companies are really trying to figure out, hey, what are the most important parts of the, the serum?
Can we just identify and package just the growth factor and, and turn that into a product for dry eye patients?
And so there's a lot of research on the ocular surface and dry eye going into, going into that space right now.
I'll tell you the one other recommendation that I always give patients.
There's a fair amount of evidence that if you're getting too much of some of these preservative chemicals, which of course, if you're going to use an eyedrop bottle for a month, it should have a preservative in it, right?
So that, you know, open the bottle and then it grows bacteria a couple of weeks later.
And now you're, you're, you know, you're using contaminated eyedrops.
So for bottles, it's typical to have preservatives, but I really recommend for patients if they're using anything more than a couple of drops here and there for their dry eye control to actually go for one of the preservative free artificial tears.
They come in lots of brands.
I'm sure the house brands at any of the pharmacies use them to make them too.
And these are the ones that come in like strips, plastic strips, and you break one off, you break off the little cap, you can use as much as you want all day.
You have to throw that one out if you have anything left over.
You have to throw it out at the end of the night and the next day break off a new one because there's no preservatives.
And once you open it, you don't want bacteria to grow in that salt water, right?
But it's really good because the preservatives can be very irritating or even inflammatory to the ocular surface, to the surface of our eyes.
So we really do want to, if we're using more than a drop or two, upgrade, they cost a little bit more money if they're still over the counter, upgrade yourself to the preservative free artificial tears.
Those are great recommendations.
I'm also really interested in this serum thing because, you know, we're this discussion taking place 10 years ago and I raise PRP, platelet-rich plasma.
There would probably be a lot of eye rolls, no pun intended, because I think myself and a lot of other people in the, it's called the sort of standard scientific and medical community looked at platelet-rich plasma right alongside stem cell therapies because they were cheek to jowl back then.
As you recall before the FDA regulations about stem cell claims, which we will get to, of course, PRP was suggested as a source of stem cells.
It turns out there are very few, if any, true stem cells in PRP.
And yet now, as I understand it, PRP is an FDA approved protocol for injection into the uterus injection into pretty much every tissue and organ system of the body in order to quote unquote

rejuvenate it.
Here, I'm not promoting PRP and yet it is a very common practice now in more standard medical clinics, but it started off kind of niche, even gray market kind of underground.
It's diverged from stem cell therapies and we're going to talk about major modes of vision loss in a moment and this horrible situation that happened down in Florida of a clinic injecting stem cells into patient's eyes to recover vision and it actually blinded them.
So we'll talk about stem cell therapies, but for the record, is PRP something that's now standard in major ophthalmic clinics, including your department at Stanford?
Are you drawing out blood, spinning it down, taking plasma, taking serum and re-injecting it or reapplying it to patients' eyes?
Not yet in ophthalmology, in eye clinics.
I would say we're sort of like right now on the edge of groups are starting to study that.
Is it safe? Is it valuable? Is it any better for certain conditions like on the ocular surface than serum tears, for example, this sort of diluting a patient's own blood serum?
So it's being studied. It's a very active area. It turns out that this PRP plasma has, again, like a high concentration of growth factors.
That's probably what's responsible for a lot of the kind of tissue rejuvenation effects, be that as they may, but it's being studied, but it's definitely not a standard of care yet at least in ophthalmology space.
And, you know, I think whenever there's something really new, it really deserves to be properly studied.
We talked before about, you know, at first you're going to do trials where you just test it carefully in a few people, maybe a few of the most severely affected patients, be really thoughtful about, you know, the ethics of trying out for safety.
Then as you develop a little understanding of the safety, you really want to eventually get to properly controlled, randomized.
What people in the community often call double blind trials, but we in ophthalmology like to call double masked trials.
Blind is a bad word.
So you really want properly controlled trials testing. Is it really working? Is it really deserve the claims that people are making?
And that has not yet really come to fruition at that level for ophthalmology or eye care yet.
So we've been talking a lot about normal visual development, eye checks, and some of the more typical challenges that people have with their vision.
But we haven't yet touched on some of the really debilitating stuff.
Things like glaucoma, things like retinitis pigmentosa, macular degeneration, the things that if we could, we would all avoid and yet are out there in the world at pretty high rates.
I'm sure you'll share with us what those rates are.
And as bad as these things are, there are ways to detect and offset their progression so that people don't necessarily lose their vision.
So if you could, could you share with us what are the major forms of vision loss in childhood and in adulthood?
And what can each and all of us do in order to find out if we have one of these conditions and

therefore treat it effectively?
Yeah, that's great. You know, let's start by just reminding ourselves what are the major causes of vision loss?
And these are going to differ where you are in the world.
But the major, the number one cause of low vision is actually refractive error.
People who need glasses and especially in other countries, affordability, access, can't even get glasses.
Okay, so that's just refractive error, but that's fundamentally correctable.
The next most common cause of vision loss is cataract.
Cataract is the blurring, the aging of the lens inside the eye behind the cornea.
We talked about how that is responsible for focusing light under the back of the eye.
It also has to be clear enough that the light gets through the lens and cataract is a normal aging process.
As I said, if we all live to 100 or 110 years old, we'll all get cataracts.
We'll all need cataract surgery.
We actually, in the eye clinic, we see cataracts years or even decades before they're affecting your vision in a meaningful way.
So the cataracts are forming and that's okay, but at some point they get bad enough that it's time to take them out.
We've actually solved for cataract surgery pretty efficiently.
We can do a four to eight minute surgery.
Maybe if we're taking our time, it's 10 or 12 minutes of surgical time, take out a cataract.
It works beautifully, 99. something percent of the time.
We put a plastic, a clear plastic lens inside the eye exactly where your lens used to be.
And there's even lenses that can flex or focus light from far and near.
So cataract is fundamentally a, there's still room for improvement, but it's fundamentally a solved problem.
The problem is that worldwide there aren't enough cataract surgeons.
There's not access to care, the machinery or the lenses cost too much money in developing countries to get out to the number of people who would need them.
So it's actually just again, an access to care cataract is a reversible, treatable, easily treatable problem.
But it's number two on the list of causes of vision loss in the world because we don't have enough access to care.
We need a lot more sort of programming around global ophthalmology, global eye care to solve for cataract, just to bring that solution to countries around the world.
Then after that, you start hitting the eye diseases that lead to what are currently irreversible, non-reversible causes of vision loss.
The number one cause of irreversible vision loss in the world is glaucoma.
So what is glaucoma? Glaucoma is actually probably a little cluster or constellation of diseases that we lump together.
It's a degenerative disease, like a neurodegeneration.
We talk about neurodegeneration in the brain like Alzheimer's and Parkinson's. Glaucoma is a

neurodegenerative disease.
It happens instead of affecting one or different area in your brain, it happens to affect the optic nerve that connects the eye to the brain.
And we need our optic nerves to carry all the visual information from the eye to the brain.
If your optic nerve is degenerating in glaucoma, and I should add, there are other optic neuropathies, so-called diseases of optic nerve degeneration.
For example, you can get a stroke of the optic nerve.
You can have an inflammatory disease like multiple sclerosis called optic neuritis that affects the optic nerve.
So you can get other optic nerve diseases, but glaucoma is by far the most common optic neuropathy.
And the problem is just like spinal cord injury, which is also part of the central nervous system, right?
The brain, the spinal cord, the retin, the optic nerve. That's the central nervous system.
And there's no regeneration.
And that's why spinal cord injury leads to permanent paralysis.
Well, optic nerve injury or optic nerve degeneration, unfortunately, leads to permanent vision loss.
So in the case of glaucoma, how do we get ahead of that?
Glaucoma has two major risk factors.
One is increasing age.
There are actually infantile and pediatric glaucomas, unfortunately.
And those can be much more aggressive, much more damaging when they present so early in kids, in babies and in children.
Most of the kind of run-of-the-mill glaucoma usually presents in adulthood and even in the aging adult.
So much more common after 50 or 60 or 70 years old, increasing.
The other main risk factor for glaucoma is increasing eye pressure.
The eye actually, you know, it stays inflated. It's a balloon. It has to stay inflated.
We need some amount of eye pressure to keep our eye as an inflated balloon.
But if the eye pressure goes too high, and we talked about this before, you won't even feel it if it slowly gets too high.
If the eye pressure goes too high, that causes glaucoma.
And that's one of the things that we talked about.
You really include in a comprehensive eye exam when you're just getting a screening checkup at your eye care provider,
at your optometrist or ophthalmologist office.
They're going to check your pressure and just as a screening tool check to make sure it's not too high.
We can treat glaucoma today by trying to reduce the impact of that high pressure, by lowering the eye pressure.
So we have treatments for glaucoma that target the eye pressure.
We have medications like eye drops.
We have lasers that can be used inside the eye that can also lower the eye pressure.

And ultimately, if we need them, we also have surgeries that can also provide an outflow that lets the fluid out of the eye in a controlled way
so that the eye pressure can be brought back down into normal ranges.
Again, the reason that glaucoma ends up being the number one cause of irreversible blindness in the world is,
number one, we can't get those therapies everywhere in the world.
The affordability of eye drops, the access to lasers or surgical procedures around the world isn't equal to what it is here.
And even within our country, people may not be accessing healthcare effectively to get screened for glaucoma or to get treated for glaucoma.
The other big problem with glaucoma is that it affects our peripheral vision first and only very late in the disease does it pinch in
and finally pinch off the center of our vision in typical glaucomas.
And that's a real problem because we don't notice if our peripheral vision is down.
You know, our peripheral vision isn't that good to begin with.
And if you're driving and you can see a pedestrian step off the sidewalk, you think your peripheral vision is fine.
But actually, your peripheral vision could already start being damaged by glaucoma and you won't notice it in regular daily life.
And that's where the importance of screening and early detection really comes in for glaucoma.
What we don't have for glaucoma, we can come back to like kind of what's the cutting edge of the future in these eye diseases.
What we don't have are treatments that really target the optic nerve degenerative process.
And we can come back and talk about that.
So that's glaucoma and optic neuropathies.
Then the next two major causes of currently largely irreversible vision loss are age-related macular degeneration and then diabetic retinopathy.
Now, age-related macular degeneration is just like it sounds.
Major risk factor is age.
It's very common.
Actually, in the developed world, countries that are more developed, also countries that have a larger Caucasian white population, it's more common in certain populations than in others.
It actually is definitely a leading cause of vision loss in the elderly population, for example, in the United States.
And there's two forms of macular degeneration, but they both end up targeting the same part of the retina.
And the part of the retina is really like the rods and the cones that we talked about before.
The rods do your low light vision at nighttime.
Primarily your cones do color vision and bright light, sort of normal lighting that we experience through most of our awake day.
And in that back of the retina, you can have what's called dry macular degeneration, which is a slow, thankfully slow, but slow, insidious disease that causes the degeneration of the rods and cones,
and also the support cells that help feed the rods and cones and take care of the rods and cones.

They're called RPE cells, retinal pigment epithelium.
It's not really critical, of course, the names of every different cell type.
But these are like the light collecting cells in our eyes in the retina, and they degenerate in macular degeneration.
And in the dry form, there's this slow degeneration.
But some percent of people with the dry form of macular degeneration will actually convert to what's called the wet form.
It's called wet because new blood vessels actually grow inappropriately under and even into the retina.
New blood vessels, unlike our mature blood vessels, tend to be leaky.
And so the fluid leaks out of those blood vessels, gets into the retina, interferes with vision, and that can lead to a much more acute loss of vision.
Now, we have some treatments for wet macular degeneration.
We have injections that can go into the eye that actually fight against the molecules that are causing those new blood vessels to grow.
And these are antibodies that can be injected into the eye, and they can be very effective controlling patients' wet macular degeneration.
It's been a much bigger uphill battle, even over the last decade, as advances are being made to really try to knock back or slow down even the dry form of macular degeneration.
There was just some exciting news, even just in the last few months.
The first successful trials of a treatment for the dry form have just shown success in properly randomized controlled human clinical trials, phase three clinical trials.
So it's an exciting time.
Those new treatments are not going to be a panacea.
They slow the progression, like the anatomic progression of the disease, maybe by 20 or 25 percent.
So patients are still going to get worse even with those treatments, so there's still a lot more to be done to really knock back macular degeneration.
I want to mention, you mentioned retinitis pigmentosa.
That's like an inherited form of a type of macular degeneration.
It's also affecting the rods and cones and also the support cells, the RPE cells in the back of the eye.
Retinitis pigmentosa is an inherited form.
There are actually many different genes you could have that could leave to retinitis pigmentosa in aggregate if you add up all the people with all those different genes.
And it can be very devastating because it can really affect the vision, knock out your vision very early in life, including in children and even versions of that in babies.
But you add that all up.
It's still much less common in aggregate than macular degeneration.
But in a way, it's quite a bit more severe because it does affect people much earlier in life.
So I sort of clumped those together.
Macular degeneration, retinitis pigmentosa, degeneration of the rods and cones and the support cells, the RPE support cells.
And then you can't have this part of the discussion about what are the devastating eye diseases without bringing up diabetic retinopathy,

especially because diabetes unfortunately really continues to grow in especially, let's say in the United States, certainly in the developed world.
You know, as we especially type two diabetes with eating habits, exercise habits contributing to a proliferation of some of the risk factors for type two diabetes, metabolic syndrome, obesity.
We're unfortunately seeing a proliferation, a growth in the number of people with diabetes.
And with the growth in diabetes, unfortunately comes a growth of the complications of diabetes.
And one of the major complications of diabetes is damage to the retina inside the eye and we call that diabetic retinopathy.
And there again, some of the same damage that occurs, especially when in diabetes, again, some new blood vessels are growing or blood vessels are leaky.
Some of that can be treated with, used to be lasers and now more commonly is often being treated with some of the same injectable drugs that are treating macular degeneration.
But there's still a lot of vision loss with diabetes and diabetic retinopathy.
I think that's an area where again, early screening, making sure if you have diabetes, that's an indication where you definitely have to be going in and getting your at least annual exam with an eye care provider or having someone take a photograph of the inside of your eye and rate that photograph to say if you have any diabetic retinopathy or not.
In terms of interventions, can we talk about diabetic retinopathy first because of course type one diabetes is a failure to produce insulin relatively rare compared to type two diabetes, which as you mentioned is proliferating in developing countries.
This is probably unprecedented in the sense that developing countries have better medical care typically than non-developed countries, more opportunities for food nourishment and yet it's clearly a problem of over nourishment, insulin insensitivity, obesity, etc.
Is this type of diabetic retinopathy that one observes the same for type one diabetics versus type two diabetics because my understanding is that type two diabetes, this insulin insensitivity is a bit of a continuum.
I mean the type one diabetes as far as I know is all or none, either make insulin or you don't.
But type two diabetes, someone could be mildly insulin insensitive or severely insulin insensitive and sometimes I'm told people are not necessarily obese and can have type two diabetes as well.
Certainly things like smoking and alcohol intake can contribute to that.
So how equivalent are type one and type two diabetes when framed under the umbrella of diabetic retinopathy?
Yeah, the time to presentation can be different.
A type one diabetic usually presents with sort of a cataclysmic sudden loss, sudden sort of final loss of their ability to make insulin.
It usually presents in childhood or teenage years but can present.
You can have late onset type one diabetes because it's kind of a sudden presentation.
It can take some years after that to show any diabetic retinopathy.
Whereas just like you said, type two diabetes can be on a continuum and people can have like kind of a mild type two diabetes but kind of be getting along, going through life.
Kind of maybe not even realizing, you know, at first.
And so when you're diagnosed with type two diabetes, you've probably had some insulin resistance for the years prior to your diagnosis.

And so in that case, you often can have, you know, like you're at higher risk for presenting sooner with the complications of diabetes like diabetic retinopathy.
Now, given that the actual retinopathy is very similar, maybe the same between type one diabetes and type two diabetes.
And again, it involves things like leaky blood vessels, new blood vessel growth.
There's some amount of neurodegenerative dysfunction that just simply occurs.
So you can have little hemorrhages or bleeding spots in the retina, tiny little strokes or microvascular events in the retina.
So that can happen in either type one or type two diabetes.
Once you start having the retinopathy, it does look pretty similar.
So what can people do to prevent or treat diabetic retinopathy?
Obviously, the type one diabetic needs to take insulin in order to survive, really.
Type two diabetics need to get their obesity under control if they are in fact obese and get their blood sugar levels under control, regardless.
That's my understanding.
And by extension, are you seeing any reductions in diabetic retinopathy with people that are taking these glucagon-like peptide mimics like ozempic, which is used to treat type two diabetes?
Yeah, that's been a very exciting development for the diabetes field.
This new class of anti-diabetic drugs.
And so you've touched on a couple of them.
There are a few key things for reducing the risk of diabetes or the impact of diabetes on your retina, risk of diabetic retinopathy or impact of diabetes on your retina.
One is, as I mentioned, get regular eye exams, be screened.
Any diabetic should be screened at least once a year with a good comprehensive retinal exam looking for any of these items.
The number one most important element to prevent diabetic retinopathy is to control your diabetes and having a real good blood sugar control,
keeping your hemoglobin A1C, which is one of the blood tests that gets used to measure how your kind of long-term diabetes management is going.
That's really, you know, first and foremost, the most important.
And that's been shown in large clinical trials.
They actually randomize patients to, hey, take care of your diabetes or do a real good job taking care of your diabetes.
And the patients who do the real good job taking care of their diabetes have much less diabetic retinopathy.
So that's number one.
It turns out that if you have high blood pressure and diabetes, that blood pressure is also really damaging to your retina.
Also, by the way, the kidneys and probably all the other organs that are suffering from the diabetic insult.
So in addition to controlling blood sugar, really important to have blood pressure under great control.
Now, both blood sugar and blood pressure in type 2 diabetics, especially if you're catching them

early, can be improved with some of these, you know, so-called lifestyle changes,
like improving eating, watching what your food intake is, you know, getting good exercise, trying to lose weight.
So these are definitely on that list of how do you get to good blood sugar and blood pressure control.
But suffice it to say blood sugar and blood pressure control right at the top.
And then also including the regular, at least annual exams.
And then if diabetic retinopathy is detected and blood sugar and blood pressure control are not going to be enough for that patient, we do have treatments.
As I mentioned before, there are drugs that can be injected if your retina is getting, you know, kind of leaky blood vessels from diabetes.
There are treatments that we can give the eye specifically to try to counter the diabetic retinopathy.
Terrific.
In terms of glaucoma, as you mentioned, glaucoma is related to pressure, although there is pressure normal glaucoma.
Glaucoma is a death of the retinal ganglion cells, the neurons that connect the eye to the brain.
And once they are gone, at least at this point in human history, they can't be replaced.
Although hopefully because of work that you've done and other laboratories are doing at some point, that statement I just made will not be true and the RGCs can be replaced.
Meanwhile, what can and should people do to find out if they have glaucoma and to treat glaucoma?
And is it true that even if somebody has normal pressure that lowering their eye pressure further protects them against glaucoma?
Yeah, that's absolutely right.
Most important is to get screened with a formal exam at your optometrist or ophthalmologist because you won't notice, you won't have any symptoms.
If your eye pressure is too high, you're not likely to notice until very late in the disease if your peripheral vision is being damaged through the course of glaucoma.
So most important as having a screening exam, a good comprehensive screening exam will always include checking the eye pressures and also looking in the back of your eye.
The head of the optic nerve where all the fibers leave the eye and carry the optic nerve information back to the brain, we can see that when we look inside your eye.
And glaucoma has a fairly characteristic look to it in the optic nerve head.
So looking at the optic nerve head, we have imaging and peripheral vision testing that can also be included in those screening exams.
So if you really get a comprehensive screening exam, you can very reliably detect if you have glaucoma to worry about or you're in the clear.
If you have glaucoma to worry about, we have treatments and you're absolutely right.
So whether you start with a abnormally high pressure or you start with a pressure that's on the face of it in the normal range, in either case, lowering the pressure has been shown in large, properly controlled clinical trials to slow the progression of optic nerve damage and vision loss.
So absolutely in either case, starting with high pressure or starting with normal pressure, in either case, you've got to lower the pressure further.
And as I mentioned, we have eye drops. Those are usually the first line. There's very good data that there's a very benign noninvasive laser.

It's not the same kind of laser that gets used for LASIK, but there's a benign, very safe type of laser called selective laser trabeculoplasty, SLT we call it.
And that's also very effective as a first line actually in the largest clinical trial from which the data have been coming out just even over the last few years.
It's called the light trial. In the light trial, patients with glaucoma were randomly assigned to either get the laser or the sort of most common first strongest eye drop and that gets used clinically.
And actually, on many features, they both worked at least as well.
But when looking out over the long term, actually the laser had some advantages over the eye drop, not in the least of which, by the way, it's very nice for patients to not have to like remember to use the eye drop every night.
And so that's quite helpful, I think, to keep in mind as a treatment option early in the course of the disease.
Of course, if the eye drops and or lasers are not enough early in the disease, we also have surgical approaches to lower the eye pressure further.
You know, even with all of our treatments, all of these treatments, stepping patients through all of this, about 10, 15, even 20% of patients will lose very meaningful functional vision.
And maybe 5, 10, 15% of patients, especially depending where you are in the world, will go blind from glaucoma, including in, you know, quote unquote, developed countries.
There's still a very significant cohort of patients that go blind, legally blind, and then, you know, absolute blindness like can't even tell if the lights are on in the room.
So it's devastating, it's insidious, it's hard to detect early.
And so glaucoma is still a tough one, even with all of the treatments that we have.
Okay, so get your pressures checked, folks.
And if you are prescribed drops, take your drops.
I hear about patients not taking their drops, which to me just seems like baffling.
But I guess having to do something day in and day out can be troublesome enough that unless people are losing their vision very quickly or they are very afraid of losing their vision, sometimes they just neglect to take them.
It's hard, it's hard for glaucoma eye drops, it's hard for taking your blood pressure medication, it's hard for a lot of medicines.
You know, if you're taking a medicine where you don't feel better, you know, if you have a headache and you take an aspirin or Tylenol or an ibuprofen, you know, you feel better, you feel reinforced.
Gosh, taking that pill made sense, right?
But if you're using an eye drop that like, hey, this is going to protect you for the next 20 years from losing your vision, but you don't notice every day that anything's better.
And by the way, the eye drops could be a little irritating.
Maybe it stings a little for a minute or two when you put it in your eye.
Some people are even less tolerant of the eye drops.
It's hard to feel motivated every day.
And we know that we call that compliance.
We know that it's very hard for patients to stay compliant with prescribed medications where they don't feel or notice a difference in a daily way.
I realize that we can't stop aging yet.

But right now you can't stop aging and age is a risk factor for glaucoma.
My understanding is so is smoking or vaping nicotine and so is alcohol.
And by that reasoning, should people strive to drink less and smoke less, including vaping nicotine less if they are concerned about glaucoma?
Yeah.
And not just glaucoma, macular degeneration.
Actually, macular degeneration has a couple major risk factors.
Macular degeneration aging, just like with glaucoma, major risk factor.
Smoking, including exposure to secondhand smoke, major risk factor for macular degeneration and for the progression and vision loss potentially associated with macular degeneration.
In the case of macular degeneration, there's also a couple of genes that we've sequenced the human genome and there's a couple of genes associated with macular degeneration too.
That's less true for your typical run-of-the-mill adult glaucoma.
There are genes for the pediatric and infantile forms of glaucoma.
So yeah, smoking 100%, including vaping, it's a no-no for your eyes, just like it's a no-no for the rest of your body.
And it's tough as the eye doctor to have these conversations with patients because you kind of feel like, well, you know, they must know it already.
And I'm trying to be the good guy in the room with the patient, convince them to use their other medications.
But it's important for us also as eye care providers to reinforce the message with our patients, a smoking terrible idea for macular degeneration, also for glaucoma.
Glaucoma is interesting because the optic nerve where it degenerates, kind of right at the head of the optic nerve where it exits the eye, it's what we call a watershed zone.
It's kind of the edge of two blood vessel supplies.
And if either of those blood vessel supplies are a little bit short on blood or oxygen supply to that optic nerve head, your glaucoma is going to get worse.
Your optic nerve is going to be underfed, and that's going to worsen this degenerative process just by not having all the right nutrients and oxygen.
So the other thing is that, especially for glaucoma, everything that we talk about for being heart healthy for the rest of our body is almost certainly true for glaucoma.
And so I also always counsel glaucoma patients.
It's not just no smoking, but eat healthy, have a multivitamin, get some exercise.
All those things that are good for your cardiovascular system are going to be good for your eyes in general, and in particular, if you have glaucoma or high risk for glaucoma.
I realize that smoking or vaping are problematic for glaucoma and for macular degeneration, but we can't have a conversation about glaucoma without at least mentioning cannabis.
I did an entire episode about cannabis, which touched on some of the real dangers of very high THC concentration cannabis.
This lost me a few followers, I'm sure, no problem because what was important was to convey the fact that the cannabis that's out there nowadays comes in a variety of different strains and ratios of THC to CBD.
There's some severe risks of high THC, especially in young males, although not always.

The point being that there are, and I want to be very clear about this because for whatever reason, cannabis gets people really up in arms.
They always say it's not as bad as alcohol, but guess what?
We did an entire episode about alcohol and there the message is very clear.
Zero is better than any and two a week is probably the limit.
And if you're an alcoholic, zero is the rule.
So with cannabis, it's clear by my read of the data that it can lower eye pressure, which may undermine the progression of glaucoma somewhat.
But if people are smoking that cannabis, is it therefore going to offset any gain that one would get from that cannabis?
And then how does one account for the potentially problematic aspects of very high THC cannabis?
Yeah, it's a great question.
And the truth is, is that in most patients, cannabis will lower the eye pressure.
The problem is, is it really only lowers that eye pressure during the period that you're high from the cannabis?
And the second problem is that smoking version of getting that cannabis into your system.
The smoking is bad for your lungs.
By the way, the smoke from cannabis or from cigarettes is also terrible for your dry eyes.
It causes inflammation.
It dries out your eyes.
So it's also very bad from that perspective.
Now, so the problem with cannabis is not that it doesn't work to lower the pressure.
We want to lower the pressure.
That's great.
The problem with cannabis is that it's not realistic for most of our patients to prescribe.
Could you go out and be high from cannabis 24 hours a day, seven days a week for the next 20 years?
I'm sure some people have tried and succeeded.
But right, that's not practical for most people.
And certainly for young people, it could be really especially problematic, I should say.
Absolutely.
So I recommend not taking that approach.
But that said, I am definitely not a decryer of it.
And now that there are edible forms, I certainly have patients who are using it in a responsible way, especially edible forms.
And in select cases, like that could make the difference for them helping to keep the pressure down.
And I'll say, for example, it turns out you've talked a lot over the last couple of years about diurnal curves and circadian rhythms.
It turns out that our eye pressure also undergoes a circadian rhythm.
And it's actually highest at night while we're sleeping, kind of peaks in those early morning hours, then hits a low throughout the early day and then kind of rises again throughout the afternoon into the evening.
And we have a lot of patients who they come into their clinic visit, their eye pressure looks normal,

but it's actually quite a bit higher when they're at home.
And that could explain some fraction of what we call normal pressure glaucoma.
It just looks normal during the day.
It's actually high at night.
And so in particular, some patients, I certainly have some patients who are using these products, like let's say before bed.
And if it's controlling their eye pressure at night while they're asleep, when the eye pressure would have been the highest, it may confer some protective advantage over time.
But that said, again, like for most patients, it's not going to be the primary approach.
I'm most excited about the idea of, you know, laboratories or companies figuring out which the compounds within these cannabinoids they're called within these products are actually responsible for lowering the eye pressure.
And could we get like a more potent, eye-specific, long-acting drug that's basically derived from the concept of cannabis but works better and is more compatible with not bringing along all the other adverse elements that can come with cannabis use.
You mentioned the circadian rhythm and eye pressure and the fact that eye pressure is higher at night.
Is there any advantage to sleeping in a particular position?
I know this might sound a little detailed, but I seem to recall an abstract or a paper a few years ago at a meeting that you and I both attended that said that if people slept with their head below their feet, eye pressures were higher than if their head was slightly elevated above their feet.
And for somebody who has glaucoma, this could make pretty substantial difference in terms of their eye pressures at precisely the hours of the night, we should say, in which they could be doing the most damage to the ganglion cells.
Yeah, absolutely. And we will sometimes counsel patients with severe glaucoma, especially if they're, you know, poorly responsive to standard therapies or poorly able to tolerate standard therapies.
We'll counsel them if they're able to sleep up on a couple pillows, get kind of a 30 degree sleep angle going.
What I don't want to do is interfere with a person's sleep because I just fundamentally feel for the total health of the whole human being getting a good night's sleep is maybe more important than that 30 degrees.
And if trying to sleep up on pillows at 30 degrees is going to lead to kind of restless, difficult sleep night, I'd rather the patient get a good night's sleep.
But if they can tolerate it, and especially if they have a sort of a tough version of glaucoma, then we'll let them try, see if they can sleep up.
The other really interesting question that arises is, does which side you sleep on affect which eye might have worse glaucoma?
Glaucoma is almost always, with a few rare exceptions, almost always a disease of two eyes, but it can present very asymmetrically.
In fact, it's quite common to have one eye kind of have worse damage than the other.
And we don't know fundamentally why that is, but one hypothesis was, gosh, maybe if you sleep on the right eye, then your right eye will have worse glaucoma because the pressure is a little higher down below.

Or maybe it's pressing on the pillow in a way or something like that.
There have been a couple studies really, really looking at that question.
A couple studies have said the lower eye will have worse glaucoma.
A couple studies have said the higher eye will have worse glaucoma.
So the upshot is it probably doesn't matter which side you sleep on.
We also know when you video people in their normal sleep pattern, even if you feel you always fall asleep on the left side of your face, people toss and turn all night.
Probably over the course of the night, you're spending a similar amount of time on each eye.
I'm glad you brought up that point.
In terms of macular degeneration, I'm curious about the things that people can do as opposed to the don'ts in order to perhaps offset macular degeneration.
One of the things that I'm intrigued by are the results of Glen Jeffries Laboratory over at University College London.
I had known Jeff for probably a decade or more and he typically worked on animal models.
But then a few years ago, I started publishing studies and I believe there are now two published studies showing how red light exposure and near-infrared light exposure done early in the day to the eye at a distance of about two feet for just a couple of minutes, a few times a week,
could offset some of the vision loss associated with age-related macular degeneration in people older than 40.
That's my understanding of these studies and there's a theory there about enhancing function of mitochondria and photoreceptors by reducing reactive oxygen species.
There's a whole mechanistic hypothesis, but my question is, is that the sort of protocol that produces significant enough offset of macular degeneration like we should all be looking at red lights in the morning?
Or is it still too early days in order to really conclude that?
I think the data is very compelling. The data are very compelling that this kind of red or near-infrared light therapy can be at some level neuroprotective.
And yes, the data suggests that kind of ramping up high functioning mitochondria as a part of that, activating neuroprotective pathways in the retina, it's actually been demonstrated in animal models and a little human data here and there.
But both for macular degeneration kind of degeneratives, but also for optic neuropathies like glaucoma and retinal ganglion cells, the cells that carry all that visual information from the eye to the brain.
They're chock-full of mitochondria too. And so the idea that this could be a therapeutic approach I think is very compelling.
There are a number of studies actually I think still ongoing today, really trying to figure out what's the right dose? How much brightness do you need? Is there an optimal wavelength? How many minutes?
Does it matter when during the day you provide that light or how many minutes or hours? These are still very much open questions.
What's the dose? What's the delivery? But it's very promising looking and there's biological premise and I'm excited to see where that goes because again, that's a very accessible therapeutic approach that could be brought to a very broad swath of people.

So I'm excited about that.
Sorry, I didn't mean to interrupt and completely noninvasive. I should probably mention a warning which is if people are going to decide that they're going to jump on this result and do red light exposure in the early part of the day, no matter what color a light is, if it's too bright, you can damage your eye.
So I think this is why you're pointing to the fact that we need established protocols before people really start blasting their eyes with red light. And if they are going to expose themselves to red light, it shouldn't be uncomfortably bright.
Do I have that?
Yeah, that's absolutely right. You know, actually, light effect, we talked about this a little bit earlier. There's actually now data also that red light and actually interestingly studies using light at the other end of the visible spectrum, violet light, either of those in smaller
daily doses can also be used to prevent progression of nearsightedness in children, in school aged children. And so I think we're really just on the cusp of really understanding the biology of how these different light therapies might be leveraged maximally to maximize our eye health, and both during development and at the other end of the spectrum as we age.
So it's an exciting area. And I think this kind of phototherapy is, you know, a very hot topic for research right now, very hot topic.
One has to wonder whether or not these light therapies, the fact that infrared works and maybe ultraviolet works, are really just capturing some of what sunlight is naturally doing when, as you mentioned before, a child or perhaps an adult also spends a certain number of hours outdoors.
I mean, maybe we're just filling in the blanks that are neglected nowadays because we're spending so much time indoors under artificial lights and in front of screens.
Yeah. Yeah. That's a very thoughtful possibility. Yeah.
I have a couple of, we don't have to call them quick questions, but common questions that perhaps have brief explanations.
For instance, I put out a request for questions in anticipation of this episode and I got a lot of people asking, what are floaters in the eye and is there anything that people can do to get rid of floaters?
Yeah. Our eye when we're born is actually filled in the middle of it with a jelly. It's not just fluid. It's kind of a jelly. There's collagen fibers and thankfully the whole jelly is largely invisible so the light can get through our eye back to the retina without being impeded.
As we age, those different fibers and gels shrink and contract and they peel off of the back of the retina so there's just in the middle.
Now, your eyeball doesn't shrink because it fills in with fluid, with saltwater basically, but the gel part shrinks and as it shrinks and also pulls, peels off the retina.
It can pull off kind of little tiny retinal bits, not important to your vision bits, but just like little tissue bits and also as it congeals, it kind of can get little concretions in the jelly and we perceive those as floaters.
It's kind of a little almost semi-translucent or in some cases kind of grayish, blackish. Sometimes you get a big one if it peels off the edge of the optic nerve in the back of the eye as happens. We call that a posterior vitreous detachment.
You can actually see like a moon or a half moon floater in your vision. These are very frustrating to a lot of people and the good news is in almost all cases they will just go away by themselves.

In theory, it's been played with, gosh, we could do like a big surgery to chew up all that jelly, replace it all with saltwater, try to get rid of your floaters. There's risk associated with that surgery.
We use it very effectively in retinal detachments or other diseases, bad diabetic retinopathy, bleeding inside the eye. We can take out the jelly from the eye, replace it with saltwater.
Putting patients through the risk of that surgery just to get rid of a couple of floaters or a few floaters that probably are going to go away over the next few months.
I actually like to tell patients it's nothing to worry about, just ignore them. Actually, if you stop focusing on them, your brain will actually start filtering them out.
You'll stop noticing them if you can kind of not worry about them, be a little intentional about ignoring them in the beginning.
And then they do actually go away. And look, some will go away. These three will go away. These two will appear. Eventually, you'll stop having floaters. Most patients will stop having floaters.
So we really don't like to put a patient at risk by intervening. We really like to, in this case, just reassure them. It's going to be okay. Just ignore them. They'll eventually go away.
Thank you for that answer.
Twitching of the eye is something that people complain about. I know when I get tired, I'll get a twitch over one eye. I think there's a condition, is it called myasthenia gravis, where people go through a stressful period or get very fatigued.
And I think that's a depletion of the nerve terminal communication between the nerves that control the muscles of the eye. And then people get this kind of like hooded eye look where they have a hard time opening their eyes.
But barring something extreme like myasthenia gravis or staying up for two days, working or even just being a bit sleep deprived. What causes the twitching of the eyelid? And is there anything people can do about that?
Most of the time, it's actually just a bad nerve ending. Maybe that one nerve cell, your eyelid is fed by hundreds, maybe it's thousands of nerve cells that are doing the muscles, they're doing the feeling.
Obviously, it's the ones controlling the muscles that can lead to a twitch. If one of those nerve cells kind of just starts, maybe that one nerve cell is dying, just whatever the age you can process.
It happens in young people too, though. So you got one bad fiber that's just deciding to kind of ring off the hook. That's that's that telephone is just ringing off the hook. And it's just activating the muscle.
So you're just twitching that muscle. I've had them as well. And you can have not just in your eyelids, you can have this anywhere in your body, like one little spot on your leg, where just the muscle right under the skin is just.
And typically, it'll happen over the course of a couple of months. Intermittently, some days more, some days less, maybe it correlates with when you're tired a little bit sometimes.
And then it'll stop that nerve cell will either reconnect properly and stop doing that. Maybe it dies. We don't really know. But typically, it lasts on that scale.
Now, there are other diseases, not just myosthenia gravis, you can have blepharospasm, like where you have a chronic spasming of certain nerves, causing muscles to spasm.
And there we can use, we can use treatments, for example, Botox is a treatment that, you know, people use for cosmetic reducing of wrinkles, for example, but, you know, a really good medical use

of Botox is preventing that blepharospasm.
And patients can come in once every three or six months if they have a really severe spasming version of what you're describing. But the regular occasional run of the mail lasts a couple months. Nothing to worry about. It does not pre-sage anything bad happening in your future. And maybe let it run its course and you'll be okay.
Great. We've all heard that carrots are good for our vision, which presumably stems from some peripheral understanding about the fact that vitamin A is integral to the photosynthesis pathway of converting light into electrical and chemical signals that the rest of the
eye and brain can use. And yet I'm guessing that there probably aren't that many people walking around who are vitamin A deficient. They're probably out there, but not that many, especially in developed countries.
And in addition, in the last really five years, but in particular in the last two years, I've seen a proliferation of supplements on the market to promote eye health and longevity of vision.
I'd love your thought on this general theme of nutrition and supplements for improving eye health or for maintaining eye health.
And before we start recording, you mentioned that ophthalmology or at least eye health is one area of medicine that has a bit, not extensive, but a bit of a longer history of exploring supplementation in rigorous randomized controlled trials.
Whereas other areas of neuroscience and neural health, such as Alzheimer's, et cetera, certainly there are brain health supplements out there, but there aren't a lot of rigorous data to support them just yet.
So what are your thoughts on nutrition? Aside from the standard thing of people shouldn't be ingesting too many calories such that they are obese and diabetic and therefore, et cetera, indirect effects of nutrition.
What are your thoughts on nutrition and supplementation for eye health?
Yeah, you know, you're absolutely right. And again, in ophthalmology, we actually do have quite a bit of studies. There's been quite a bit of attention over the years, even over the decades, looking at this question.
And I think it's worth highlighting a couple of yeses and a couple of noes.
For macular degeneration, which we talked about being an exceedingly common cause of vision loss, there have been two age-related eye disease studies called ARIDS, age-related eye disease studies, ARIDS, there was ARIDS and then ARIDS II.
And those studies were large, randomized trials of giving patients supplements. And in ARIDS, it was vitamin C and E, higher dose than would just come in a multivitamin, zinc and copper, and then also beta-carotene.
And beta-carotene is one of these, what are called carotenoids. If you look at the extended family, there's maybe 600 different chemical entities of these carotenoids.
And beta-carotene is one of them that's in the direct pathway of making vitamin A. And so that was the principle in the ARIDS study.
And the ARIDS study showed that patients randomized to these pills compared to controls, these are antioxidants in part, right, in addition to feeding into that vitamin A pathway.
And the patients randomized to get that supplement mixture showed less progression of their dry macular degeneration in the moderate to severe ranges.

If you had mild macular degeneration, they didn't show a statistically significant improvement, but I will say it's my experience, you know, myself with patients and seeing how the field works.
You know, if you have mild macular degeneration, even though it's not as clinically proven, we're still often recommending, hey, if you can afford that supplement, go ahead and buy that.
Now, ARIDS was then followed by a second study, ARIDS 2, also with vitamin C, vitamin E, zinc and copper.
They actually tested whether a slightly lower dose of zinc would be as good as a higher dose, and a lower dose was as good as a higher dose.
And then instead of the beta-carotene, they tested against the beta-carotene, they tried two other carotenoids that are called lutein and zeaxanthine.
And they actually found head to head that the second, the ARIDS 2 formula without the beta-carotene and with the lutein and zeaxanthine, that that formula was even better at slowing dry macular degeneration in the moderate to severe population.
Again, it's not clear how much it may help mild macular degeneration, but in the sort of clinically defined moderate towards severe group, there was a statistically significant...
It reduced it by about 20-25% the progression of your dry macular degeneration.
And over a couple of years, 20-25%, you may not notice, but over a couple of decades, that could really slow down the progression of your disease.
Now, it turns out that the beta-carotene, they noted a little bit of an increased cancer risk in the patients in the ARIDS 1 who had that beta-carotene, mostly in patients who were smokers.
They also noticed in the second one that if you were already not taking a multivitamin or not eating a diet that's already naturally rich in lutein or zeaxanthine, that the effect of that supplement was even stronger.
So it was very strong clinical trial support for taking what we now use this ARIDS 2 supplementation, and I'm sure we can list the formula or put it in the links under your podcast, that this really does slow macular degeneration.
So that's like a very strong example of a yes, you should do this.
There's one, yes, brewing in the glaucoma field right now, and that's high-dose vitamin B3. B is in boy 3. It's also called, in its various forms, either nicotinic acid or nicotinamide.
The nicotin sounds like nicotine, but this is not a substitute for smoking or vaping. This is a different, this is a vitamin that just has a very similar sounding name.
It's in the NAD synthesis pathway, correct?
Exactly right. It's in the NAD pathway. NAD is one of the oxidative stress regulators and energy regulators of our cells. So it's a very critical molecule in the metabolism of our cells.
And there was very strong evidence in preclinical models of mice given glaucoma that manipulating this pathway and sort of increasing this pathway could be protective in glaucoma or other optic neuropathies, optic nerve degenerative diseases.
And so there have now been two limited but randomized controlled clinical trials. One looking at glaucoma patients, looking at their visual field, so their actual visual performance.
And the other looking at the electrical signals in the eye called an electroretinogram, kind of like an EEG does for your brain. We can do an ERG for your retina.
And in both of those trials, high dose vitamin B3 was A found to be very safe and B was shown to actually improve, at least in the short term, improve retinal function measured either on visual field

testing or on the electroretinogram.
Now, this is now entering clinical trials, large kind of phase three style clinical trials actually around the world. It's a very hot topic for glaucoma, the fact that this NAD boosting supplementation with high dose vitamin B3 might be a great approach to helping protect the nerve in glaucoma.
And so as I say, there's there's three or four large randomized phase three style clinical trials starting now. And so over the next year or two, we'll get more data.
But I'll tell you, like, I have patients. And if they're at the end of their rope, and we are having a lot of trouble controlling their vision loss from glaucoma, I'm already recommending in these limited cases, hey, why don't you try this?
It's almost certainly safe. And it may and it may help and it may help protect your vision over time.
So so that's that's an area that's kind of another like kind of could be a yes, early data is pointing in the right direction.
You want to be careful, but but I am starting to recommend it at the same time that we're actually doing the clinical trials.
Now that said, there are a lot of other things that people talk about other supplements.
Ginkgo biloba, things with generic names on the internet, like, you know, glaucoma preservation.
Oh, goodness. Yeah, that sort of thing makes my gives me hives.
Yeah. And these are areas where there might be scientific premise, like a plausible explanation for how this should help, but not good data that it actually helps.
Thankfully, in most cases, these things are safe. But I just worry about patients hitching their wagon to something that's not going to help them getting their hopes up.
Worst case scenario, not taking their actually proven prescribed treatments and instead using an alternative therapy that doesn't have data to support it.
And so I think there there's a lot of, you know, you know, either unfounded unsupported, you know, information that travels around chat rooms travels around the internet.
One person tells the next person, you know, there's inappropriate advertising for some of these.
And there, you know, I really don't want patients to be hurt, not necessarily hurt by taking something that's not helping, but but maybe hurt by feeling like I don't have to go to the doctor.
I'm taking this supplement and that would be obviously a really bad potential outcome for a patient.
I completely agree. Supplements are just as the name suggests, a supplement to an already hopefully healthy lifestyle and use of medication where it's prescribed.
And I've often said on the podcast that sometimes the best dose of a supplement is zero milligrams.
So I do appreciate you touching on those themes because supplementation is something that comes up from time to time on the podcast.
And I know that I've certainly have seen a number of these different eye and vision support supplements.
We aren't affiliated with any of them.
I don't personally take any of them, but these clinical trials sound promising.
So I'm going to keep an ear to the ground for them.
As a final question and hopefully a topic that we can cover in more detail in a subsequent episode of the podcast, because I absolutely want to have you back to discuss this in more detail.
I'd like to just get your thoughts on the fact that the neural retina is in fact neural and it's part of the brain.

And we are hearing an increasing amount of positive chatter about the use of imaging the eye and the retina directly as a way to detect other forms of neurodegeneration.
It's that are listening or for watching, you know, I'm putting my hands up and kind of see shape at the back of your eyes lined with these with this three cell layer thick thing that is the neural retina, which are really pieces of brain.
They connect to the rest of the brain and because it resides in the eyes and outside the cranial vault, people like you skilled clinicians with the appropriate tools can look into the eye and see the brain directly without having to cut through the skull.
And my understanding is that more and more ophthalmologists are seeing cases where degeneration of the retina is correlated with degeneration of structures deeper in the brain, making imaging of the neural retina perhaps one of the best diagnostic tools for predicting and tracking the progression of Alzheimer's and other forms of neurodegeneration.
Do I have that right?
Yeah, absolutely. Actually, this is a super exciting area.
We have this long standing saying in ophthalmology that the eyes a window to the brain, the eyes a window to the soul, of course, is a long standing saying, right?
And it turns out that, you know, in Alzheimer's disease as an example, you know, we really talk a lot about the degeneration of basal forebrain colonergic neurons that are leading to the cognitive deficits in Alzheimer's disease.
But it turns out that there is also some degeneration throughout other areas of the brain, including the retina.
And since we have such a relatively easy time imaging the retina, you can go into your doctor's office and get a quick little sort of laser scan of the retina, a picture of the retina, compared to like going through a full MRI process for your brain.
And we can detect the degeneration of the retina and optic nerve associated with Alzheimer's disease.
It looks like the same thing is happening in Parkinson's disease and MS.
Now, one of the issues is that in a lot of these degenerative diseases, we're able to detect the difference in the retina, but we're not necessarily able to say, hey, if we see this in the retina, it's multiple sclerosis.
But if we see that in the retina, it's Alzheimer's disease.
So there may not be, there may be good sensitivity to detecting the disease and to following whether your brain disease is getting worse.
But there may not be very good specificity differentiating the different diseases.
And I say that with a very big asterisk at the end of that sentence, because there's actually amazingly cool new data.
One of our colleagues who you know, Alf Dubra, has helped revolutionize a new way of imaging the retina that's giving us now cellular resolution and even subcellular resolution, seeing things smaller than the sizes of cells inside our retina.
And recently in one of his projects, he's teamed up with another one of our faculty, Heather Moss.
She's a neuro ophthalmologist, so she really specializes clinically in the eye brain connection and her research focuses on that.
And together they made actually an amazing recent discovery of very specialized unusual novel

structures that they can detect in the retina of patients with multiple sclerosis.
And whether these kinds of discoveries or other similar kinds of discoveries are going to lead to kind of a whole new generation of biomarkers, which are ways of measuring disease, diagnosing who has the disease, figuring out who's getting worse from the disease,
figuring out who's responding to therapies that we're trying to use to treat the diseases is a very exciting area.
And this really touches on what we're all hoping is the future of eye care as well as the rest of medicine.
And that's precision medicine, but also what we call precision health.
We really want to not just figure out what drug treatment to give this patient versus that treatment, but we really want to figure out who's at risk of even getting some of these diseases.
And gosh, we could interview now and prevent them from ever getting in trouble in the future.
Fantastic. Can't wait to hear more about those developments.
And listen, I want to say, on behalf of the listeners and myself, just thank you ever so much for the discussion today.
I don't think I can ever recall a conversation that's included so much basic science and clinical science and also so many actionable recommendations, both do's and don'ts, as it relates to something so critical as eye health.
I also was just reflecting for a moment about the fact that I think you and I met 20 years ago when you were a graduate student.
By the way, folks, Jeff is sort of a Kobe Bryant of sorts, although fortunately still with us in the sense that he went directly from his MD and PhD, skipped his postdoc, didn't require one directly to being a faculty member.
Most people don't do that. They do a five year postdoc in between.
Wait. And then I believe he's going to tell me all the places I'm wrong and I should just come clean that Jeff is my chair of department at Stanford School of Medicine Department of Ophthalmology.
So for me, I see this as a particularly warming but also at once unpredictable but pure pleasure of an experience to get to learn so much from you because I don't think we've had this long to sit down and talk science in a very long time.
So thank you for doing that for my own sake. Thank you for teaching us so much about how to take care of our eye health.
And now you can tell me where my history is wrong. Maybe my hippocampus is degenerating.
No, it's been a pleasure over the years. I have nothing but the warmest memories of you as a postdoc and me as a graduate student getting to be, you know, nerds in the laboratory.
20 years ago, 20 years ago at Stanford in the lab of Ben Barris and very warm, wonderful feelings about, you know, learning science and how to do science and making real advances even at that time.
And then the fact that we've had the chance to cross paths in San Diego again at Stanford collaborate on important projects having to do with, you know, developing new ways of measuring diseases, developing new ways of treating diseases.
The idea that we're going to actually bring forward some of the advances that our lab, that your lab, that other people's labs have been making in neuro protection in diseases like glaucoma macular degeneration in regeneration of the optic nerve of the retina.

We're real close on a lot of those. This is a major topic of really the cutting edge research that we're really trying to keep pushing forward because we know it's so important to patients.
You know, I often joke, you know, my mother had a sign outside the bathroom and it said, remember how long a minute it is depends on what side of the door you're on.
And I really appreciate that like as fast as we're trying to go with our research and moving that into clinical research, which I think we're doing very effectively in the department, really working on vision restoration research in the department.
I appreciate that as fast as we think we're going, it's not fast enough for so many patients who are suffering from these diseases. So thanks very much for having me on. It's been a real pleasure reconnecting over these many important topics.
I really appreciate the chance to talk with you.
I'm delighted to do it and looking forward to doing it again. You're an amazing colleague, friend, clinician and now public health educator. Thank you.
Thank you for joining me for today's discussion all about I envision health with Dr. Jeffrey Goldberg. I hope you enjoyed the discussion as much as I did.
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I do read all the comments during today's discussion and on many previous episodes of the Huberman Lab podcast. We discuss supplements while supplements aren't necessary for everybody. Many people derive tremendous benefit from them for things like improving sleep for hormone support and for improving focus.
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Thank you once again for joining me for today's discussion with Dr. Jeffrey Goldberg.
And last but certainly not least, thank you for your interest in science.
Thank you.