

CLASS OF 2020

A black and white photograph of a television set. The screen displays the title 'SCREEN TIME' in large, bold, white capital letters. Below the title, the author's name 'By Abby Rakotomavo' is written in a smaller, white, sans-serif font. The television is centered in the frame, and the background is dark, with a subtle glow around the screen.

SCREEN TIME

By Abby Rakotomavo

INDEPENDENT STUDY

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INTRODUCTION

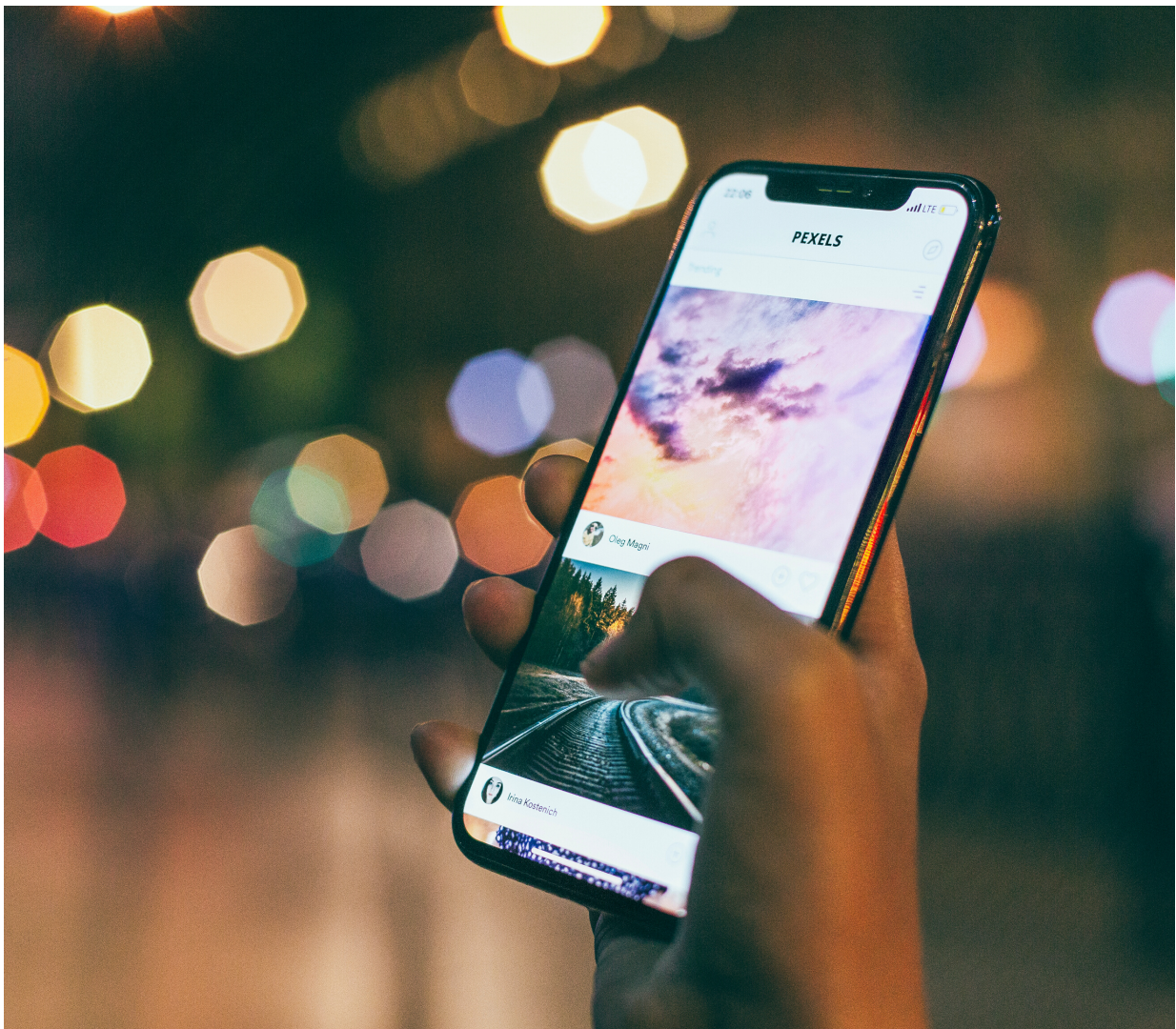
My topic is all about the ways screens affect our health and lives, short term and long term. At first, I had absolutely no idea what area I wanted my independent study topic to be in. I looked into a lot of very different things before settling on Screen Time. "Why?" you might ask. When I was brainstorming some things I was interested in that could potentially become my topic, I thought of screen addiction. I've always spent a lot of time on a screen, ever since I was introduced to my first iPad when I was about six or seven years old. I remembered talking with Clancy (even before we were discussing our independent studies) about cellular device addiction. I brought it up a few times, but during the search for a topic, it never crossed my mind. I think that's because I had a smaller understanding of what sustainability really was and how screens are related to that theme, so my mind subconsciously ruled it out as a possible topic.

That leads me to talk about the ways my topic is related to sustainability. Near the beginning of the year, my class did an exercise to broaden our understanding of this concept. First we learned about the Pillars of Sustainability. They are three pillars that hold up an imaginary building that represents sustainability. The pillars are called: Profit (money), People (society), and Planet (the environment). Then we put up three signs next to each other that were named after the three pillars. Maxx or Clancy would shout something out and we would stand in the line of either Profit, People, or Planet depending on what we thought it was most related to. My topic can fall into all of them, you just may need to think harder about it. It fits into Profit, because the more people use phones, tablets, computers and the like, the more that industry earns. Screen Time also fits into People because it affects the direct welfare of humans, and screens are very common in modern society. It can also fall into Planet because the more we use them, the more all of the materials made to create our screens are used up and wasted.

But there is still a lot that I don't know about my topic. I learned a little bit about how screens can affect our learning abilities, but I would like to know more about the ways small children that are exposed to screens early on can have trouble with learning reading and writing, for example.

The thing about my topic is that there is a lot of controversy, specifically about whether or not screens damage your eyes as much as they are believed to. Sometimes it was hard to find reliable sources or facts that I could trust. I also had to be careful of when some articles were published, because a lot of the time, the facts presented in an article from a while ago are corrected or built upon over time.

Overall, I'm proud of how it has come out. My paper feels strong, and I really like the idea of my project, which I will explain later. However, you should keep in mind that all of the things I mention throughout my paper and parts of this eBook aren't guaranteed to happen to everyone. Most of these problems occur over long periods of time of using a screen for longer than is healthy. And even then, not everyone responds to the effects of screen-usage on our bodies in the same way. But this eBook will cover many aspects of my topic, from what blue light is and how it causes harm to humans to how excessive screen time can cause eating disorders, and more.



SNIPPETS OF AN INTERVIEW WITH DR. MICHAEL KAPLAN

The first question I asked in our email exchanges was **does age have an impact on how screens affect people's minds and bodies? If so, how?**

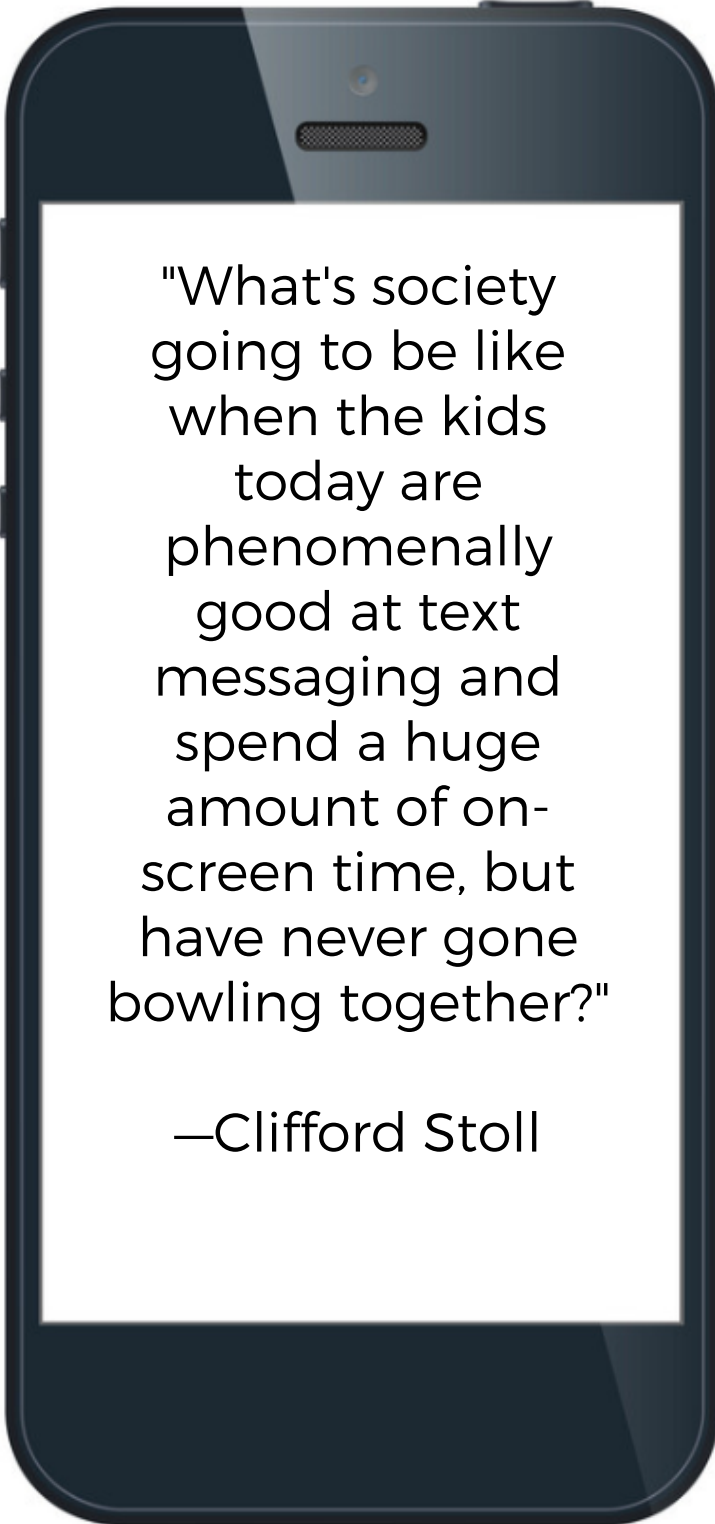
Yes, sure, and that's a really good place to start because we know with children that they're changing all the time, and not only are they changing on the outside, you're getting bigger and stronger, your body changes, but we also know that things about you change like your psychology and your emotion and things you can learn. And all of those changes happen because of changes in the brain. Even though we can't see inside the brain, obviously, we know that anything that is happening on the outside is happening on the inside. So anything that affects your growth and development means it's affecting your brain. And we also know that in different times in your life, different things can affect you in different ways, so we know that the brain is growing very, very rapidly in the first years of life and that things a kid might be exposed to early on might have a bigger impact. Now, for an example, have you heard of lead paint and how bad lead paint is for people? If you are exposed to lead paint when you are younger and your brain is still forming, it's going to have a bigger impact than if it's affecting Clancy or Maxx. So lead paint has a bigger effect when you're growing because the brain is kind of like clay. You know, so if you've ever worked with clay, and you are molding it into a shape, you know when you start with it, you can sort of turn it into anything. But once you put it into a kiln, or fire it up, it's pretty much locked in place. And so at the beginning of the process, you have more of an influence and impact. Is that making sense to you?

Yeah, yeah.

Ok, the answer is yes. Yes, it has a different impact at different ages. It has a bigger impact the younger you are. So, we know that the brain is not fully formed until you're about 25. We also know that it grows in some spurts. In the first three years of life it's having a really big spurt or growth. And then it's still growing and growing, and then there's another spurt when kids go through puberty, and then there's another big spurt when the kids are in college. So while it can have a big impact at any point, we know, to answer your question, the earlier, the bigger the impact. Because what's happening in the early years of life is your brain is still figuring things out, and it's wiring itself based on experiences you have. So if you have certain kinds of experiences, it'll wire itself in that direction. A useful example of that would be learning languages. And we know that kids can learn any language when they're born, and I like this as an example because your brain doesn't know where you're going to be born. But we do know, for example, that up to about six months of age kids wherever they're born can hear and appreciate any language. But after six months of age it starts to change. So if you're born in Japan, or China and hearing an Asian language, you don't need to know if there's a difference between r's and l's. And we know that Asian babies, and for example, American babies can hear every vowel and every consonant and every combination. But after six months of age, based on the experiences that brain has had by the languages they are hearing, things start to change a lot and by the time that baby is 12 months old, they can't hear the same distinctions, say, we can't hear the same distinctions they can or vice versa. So based on the experiences you're having, your brain is getting wired. When it comes to things like screen time and media, we know the younger the child, the more it's going to have an effect in certain kinds of ways. Now, we know for things like learning basic intelligence, and learning how to read, it can have a bigger impact—we'll talk about that later—the younger the child is. We also know, in terms of media, that aggressive media can make people more aggressive and sort of prone to aggression. For example, if you're never going to be an aggressive person, you can watch a violent video, not that I recommend it, it's probably not going to have a big effect on you. But if you are more prone to being aggressive, and use your body to solve problems, that child watching violent videos, is going to be more likely than if they didn't watch violent videos to act more aggressively. So at different ages, it's going to have a different effect, but all throughout childhood, watching too much media and that kind of media can have a different impact on your growth and development. And there are certain things that no matter what age you are, like sleep and appetite, spending too much time in front of a screen can have an impact on adults as well. So my answer is it can affect you no matter what age you are, it has a bigger impact the younger you are, and it can have different kinds of effects depending on what age you are.

So you kind of talked a little bit about this, but the next question is how can spending too much time in front of a screen change people's behavior?

That's probably the most important question. We have a lot of research now that's looking at that very question, because we all want to know the answer to that question. And what we find is that it can have a big impact, so an important thing is how much you watch and the kind of stuff you watch. So, if you watch things that are educational, it's different than playing Super Mario Brothers, right, which I would argue is not educational. Or if you're playing violent video games, you're doing different things. So if you're five years old and watching PBS or Sesame Street or something educational, and you're learning, that's the quality. So your question is about the quantity. So yes, we do know that too much screen time can affect a lot of things. We know it can affect learning, kind of like the ability to learn reading and math skills, we can now in terms of behavior expect sleep and eating. It's very clearly shown that if people spend too much time in front of screens, they're more at risk of developing obesity. That's a real, hard fact. The other hard fact about behavior is sleep, which is a behavior. We know that people who spend too much time in front of screens are more likely to develop insomnia, which is trouble sleeping. So between sleep and weight gain, we know they have a big effect, and in terms of weight gain, the more direct impact is that people who spend too much time on screens are spending less time moving. So they're less likely to get regular exercise or even regular movement, like a normal movement that someone has each day and would help them stay healthy. The other area of behavior that we know of, you know, there's learning, there's sleep, there's weight, and then the fourth area I like to think about is social interactions. So when people are spending too much time in front of screens, they're cutting down the amount of time they would spend talking to someone and engage in social interactions. And we know for kids that it's really important for their brain development to be having face-to-face interactions with their family, with their friends, and with their teachers. And so if someone is spending too much time in front of a screen, it cuts down in the face-to-face interactions. And that also gets back to learning. So, Abby, an interesting thing that we know is that people learn best from people, and not necessarily from screens. Screens should be something that augments and enhances our learning, but they shouldn't be the primary way of learning. There have been studies that have shown that if you take a group of kids and divide it in half... if you take half of them and teach them something with a teacher, and take the other half and have them learn it from a screen, the ones who learn from the teacher are much more likely to remember it when it's been taught by a human being live in front of you. What makes us human is that we're very, very social and that we rely on other people for lots of things. So we know that the kids who learn it from a screen, they're going to learn less, they're going to be less social, they're getting fewer interactions, and they spend less time with family and friends because they're mostly looking at a screen, and not looking at another person. So those are some of the ways in which screen time can affect behavior.

A dark blue smartphone is shown from a front-facing perspective. The screen is white and displays a quote in black text. The phone has a small camera and a speaker grille at the top. The quote is centered on the screen.

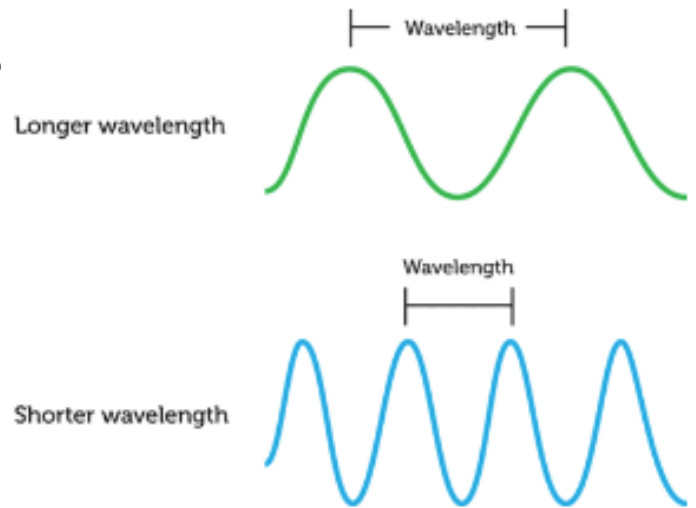
"What's society going to be like when the kids today are phenomenally good at text messaging and spend a huge amount of on-screen time, but have never gone bowling together?"

—Clifford Stoll

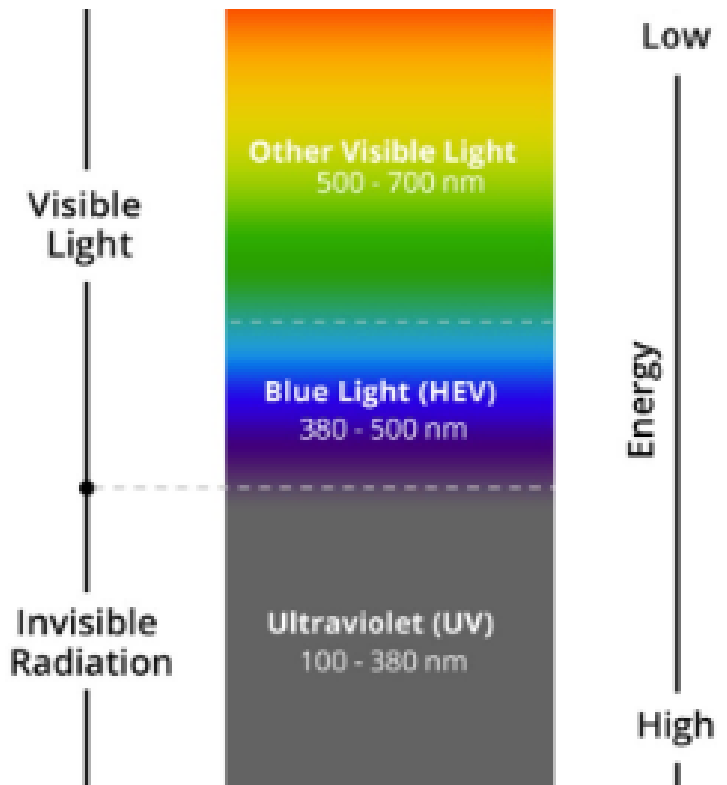
WHAT IS BLUE LIGHT?

Did you know that blue light surrounds us every day? Sunlight is made up of different kinds of light: ultraviolet, infrared, and visible light. When all of those are combined, it creates the white light we see. A lot of that sunlight is made up of blue light, as it has the highest energy. However, there is also such a thing as artificial blue light, which is just a human-made version of the natural light we see. Screens radiate that artificial blue light, which is on the spectrum of visible light to the human eye. You can really find it in any device with a screen (or a display device) such as a cell phone, a computer, or a tablet. You can also find it in LED and fluorescent lights. These might be more energy efficient (in other words they use less energy, which is better for the environment), but they produce more blue light than other sort of lightbulbs.

To understand more about blue light, let me tell you about wavelengths. Light waves are forms of electromagnetic radiation. Electromagnetic radiation is the waves of the electromagnetic field (a literal field of force that is electric and magnetic) that travel through space and consist of radio waves, visible light, gamma rays, and X-rays. They are made up of wavelengths, which are the spaces in between each slope of the wave (they are measured in nanometers or 'nm'). The shorter the wavelength, the higher the frequency and energy.



A longer wavelength compared to a shorter wavelength



The visible light spectrum and its wavelength measurements

HOW SCREENS AFFECT SLEEPING

"The other hard fact about behavior is sleep, which is a behavior. We know that people who spend too much time in front of screens are more likely to develop insomnia, which is trouble sleeping."

You might already know that screens can prevent you from sleeping and staying on your sleep schedule, but do you actually know why?

Remember what I just said about artificial blue light? It can affect your body in a lot of ways, and one thing it throws off rhythm is the circadian rhythm. Your circadian rhythm is often described as an internal clock, as it dictates your sense of time. In the daytime, your brain processes all the blue light around you and knows that it is sunlight, therefore signaling that it is morning and you should stay wide awake and alert. And the opposite is true too: when it's dark, your brain knows that it's nighttime and that you should go to bed. However, your brain does not know the difference between natural and artificial blue light, so when you are using a screen in the dark, it appears to your brain that it is still daytime and keeps you awake.

Blue light can also disturb some of the hormones in your body. The most common hormone that blue light affects is called melatonin, which is the sleep hormone. To understand more about this you have to know about the suprachiasmatic nucleus (SUP-ra-kai-as-mat-ik NU-klee-us), or the SCN. It is part of the hypothalamus, a small region near the base of the brain that plays a big part in releasing hormones. Light mainly stimulates the SCN, causing it to set off a bunch of reactions in your body like sleeping. The SCN sets off a response in the pineal gland, whose job is to produce our good friend, melatonin. Though it also helps in the realm of awakesness or awareness. When it senses that light is around, it can do multiple things: increase your body temperature, release a hormone called cortisol (cortisol does many things, one of which is to regulate your metabolism, which is what converts food to energy), etc. The circadian rhythm and the SCN are similar in the sense that they tell you when to sleep (or help in the process of making you fall asleep) and they can both play a huge part in your sleep patterns when they're disturbed by blue light. Although the circadian rhythm is more attuned to your sense of time, while melatonin helps you relax before sleeping.

All this also has a direct effect on your sleep cycle. Everyone's sleep cycle is basically split up into two categories: Rapid Eye Movement (REM) sleep and non-REM sleep. There are four stages within those two categories. Non-REM consists of three stages named N1, N2, and N3. N1 is the state of drifting off, a transition from being awake to asleep. This stage usually lasts from one to 10 minutes; it slows your heart rate, eye movements, and breathing down while also relaxing your muscles and lowering your body temperature. This is the lightest stage of sleep, so everyone can be easily woken from it. Think of it as dozing off accidentally. People who were woken in N1 would likely not know that they had even fallen asleep at all.

Stage N1 sleep



Stage N2 sleep
Sleep spindles



Stage N3 sleep



An electroencephalogram (e-lek-tro-in-SEF-o-lo-gram), usually referred to as the EEG, is a test that scientists use to monitor the electrical activity in a brain. The technicians attach electrodes, small disks made out of metal, to your scalp. Stage N1 has the lowest voltage out of all the stages. Above is a picture of the brain voltage in the different stages of sleep monitored by the EEG.

You'll notice there is something in the picture called a sleep spindle. It's pretty much just a burst of activity and energy in your brain that has a frequency ranging from 11 to 16 hertz. These can last anywhere from half a second to three times that. This leads us to talk about stage N2 sleep. Stage N2 is also a light stage of sleep, though it has a higher voltage and lasts for about 10 to 25 minutes instead. It's another stage of relaxing, that completely stops any eye movement and slows everything down even more. It's also worth mentioning that this sleep cycle repeats through the night, and people spend more time in stage N2 sleep than any other stage. Next is stage N3. This is a stage of very deep sleep, and your brain is a lot less responsive to any outside activity, therefore making it harder to wake up from. Lasting 20 to 30 minutes, this stage slows everything down as much as possible and your blood pressure drops very low, but not to that of a dangerous level. This is where sleepwalking, talking in your sleep, nightmares, and night terrors tend to happen. Scientists aren't quite sure why yet, but younger children and babies spend more time in this stage of sleeping, and the time spent in N3 decreases with age.

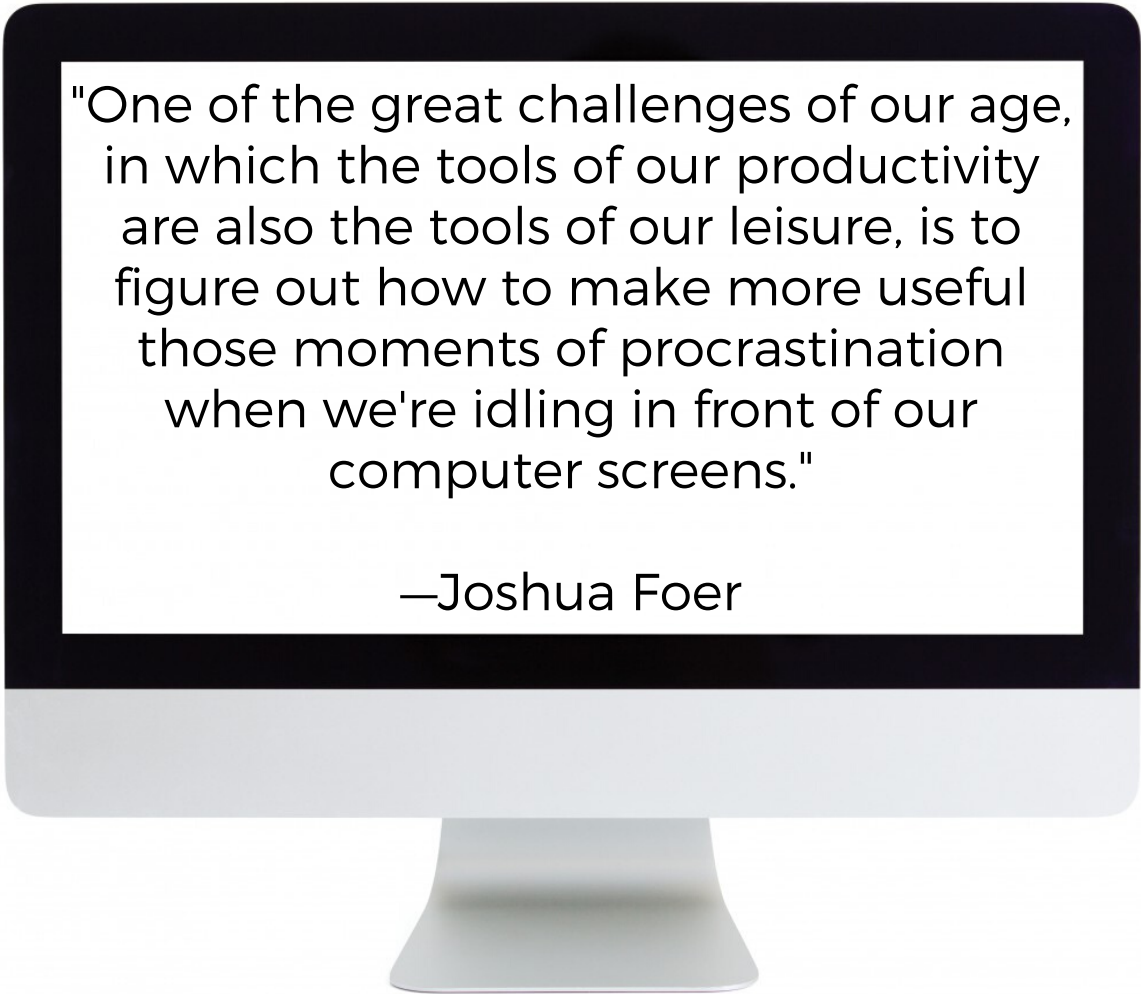


The last stage is REM sleep. It usually happens about ninety minutes after a person has fallen asleep and gone through all of the non-REM sleep stages. Usually lasting 10 minutes in the first cycle, the amount of time in REM sleep increases every time the person completes a cycle. As a reminder, REM stands for Rapid Eye Movement, and this stage is named after the fact that when a person is in REM sleep, their eyes move quickly from side to side while their eyes are closed. Although scientists aren't exactly sure why this happens, it is often closely associated with dreaming. People who wake up during REM sleep are a lot more likely to remember their dreams, or at least part of them. In this stage, your heart rate actually quickens and your blood pressure rises slightly instead of dropping. Your muscles relax so much, they are like dead weights and practically incapable of moving. Some sleep experts even argue that this is the stage where your brain is the most awake.

You're probably wondering how exactly screens can disrupt all this. There are a few ways; first, think back to the circadian rhythm and melatonin levels. Once those are thrown off course, your brain is still wide awake, which will inevitably make it harder for your body to enter stage N1 from wakefulness. That, among other things, causes the normal amount of time spent in each stage to be scattered and messed up. So you might spend less time than you should (or more for that matter) in any given stage than what your body is used to. This likely will leave you feeling unrested or groggy when you wake up, even if you went through all the appropriate stages of sleep. This happens because your body is used to spending a set amount of time in each stage, and if your cycle gets messed up, you won't feel as rested in the morning.

This whole chapter has been about the ways blue light can affect your sleep. Now is the time to explain the sorts of things that can come out of all this disrupted sleep. A lot of the people that develop disorders linked with sleeping problems are developing them because of screens. Take insomnia as just one example of a very common disorder caused by lack of sleep. It is a disorder that causes people to have a lot of trouble sleeping and can make large impacts on your body in various negative ways such as low energy, moodiness, and trouble focusing or learning.

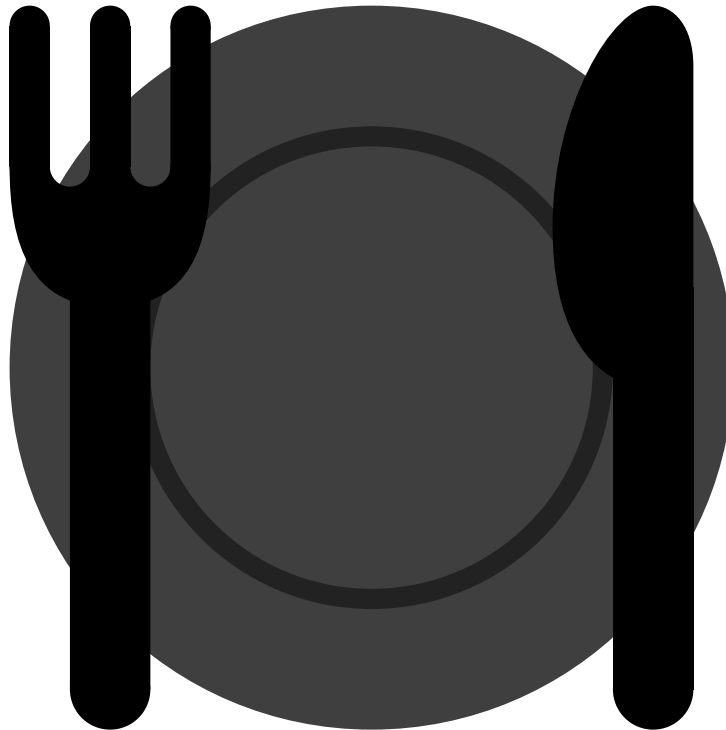
According to the American Academy of Sleep Medicine, about 95% of Americans between the ages of 18 to 44 have stayed up late and lost sleep because they were doing something on a screen. 72% (from ages 18 to 34) stay up because of video games, and 75% of men lose sleep from watching sports. So as you can see, screens really do cause a widespread problem, especially in America.

A computer monitor with a white bezel and a light gray stand. The screen is black and displays a white rectangular box containing text.

"One of the great challenges of our age, in which the tools of our productivity are also the tools of our leisure, is to figure out how to make more useful those moments of procrastination when we're idling in front of our computer screens."

—Joshua Foer

HOW SCREENS AFFECT EATING



Sleeping is not the only big part of our health that blue light directly affects. Obesity or other weight-gain problems are also things a lot of people struggle with. But did you know that a lot of people that have obesity got it because of screens? Like I said before, blue light affects multiple hormones in different ways, not just melatonin.

Let me explain the two main hunger-related hormones: leptin and ghrelin. Leptin is a hormone that is produced by fat cells inside something called adipose tissue, which is literally just fat. Leptin is basically a hormone that controls food intake and balances out energy so that we don't waste or spend all our energy at once. It is what makes us maintain our same body weight. Since this hormone comes from fat cells, it has a direct impact on fat levels. For example, people with more body fat will have a lot more leptin in their body than people with a normal amount of body fat. People who have decreased the amount of fat in their bodies will have less leptin in them, which is healthier than having too much. So what exactly does an increased amount of leptin in your body do? Higher levels of leptin in your body can cause a disease called obesity. I will explain more of that later, but all you have to know now is that people with obesity have extremely high amounts of leptin in their body, since it is produced by fat cells.

I also mentioned that there is another hormone related to leptin, and that would be ghrelin, also called the hunger hormone. Ghrelin is produced in your stomach, and is called the hunger hormone because it is what makes you want to eat. It also plays a part in fat storage, not unlike leptin. Some studies have shown that ghrelin can increase the amount of food we eat by 30%. But ghrelin can also have some effects on your heart and vessels, or cardiovascular system. Ghrelin plays a big part in producing insulin, which is yet another hormone related to hunger or food. I won't go into too much detail, but insulin is what controls how we use carbohydrates from the food we eat. Carbs produce something called glucose, which is basically sugar. Insulin makes certain parts of our muscles, liver, and fat let the glucose into them. Without our trusty insulin, those parts of your body will start malfunctioning, as they need insulin to help them turn the glucose into fuel. So ghrelin is very important for our health and wellbeing. However, once again, blue light increases the amount of ghrelin that is produced in your stomach, which then makes you feel like you are more hungry and have to eat more.

I said I would talk more about obesity, here it is. Obesity is a medical condition (now a disease according to the American Medical Association) where people have so much extra body fat to the point that it becomes very unhealthy. Obesity can also lead to a lot of other medical conditions, especially those relating to the heart. Some of those include heart disease (from increased blood pressure and high cholesterol), strokes, specific kinds of cancer, type two diabetes, and a lot more. Now that you know about leptin and ghrelin, I should tell you this: even though you would probably think obese people have higher levels of ghrelin, they actually don't. That's right, people with more body fat have lower levels of ghrelin and higher levels of leptin. Just think about it, the more you eat, the lower the levels of ghrelin in your body.

Since obesity comes from over-eating, they will feel a lot less hungry. But they do have unnaturally high levels of leptin. Some think it's because their brain is less receptive to leptin, so even though they have enough (or more) fat than they need, they keep eating. This is called leptin resistance. However blue light isn't the only one responsible for all of this, but in a way you are too. Exercise is a very important part of staying healthy, and if you spend most or all of your time on a screen, you are not definitely not getting enough exercise as you should. This is a contributing factor to obesity, as you are willingly staying inside on a screen rather than going outside and getting fresh air or exercising. So at the same time, you have to make sure you exercise and get outside enough.

"It's very clearly shown that if people spend too much time in front of screens, they're more at risk of developing obesity. That's a real, hard fact."



So how much exercise is enough? It varies depending on your age, and many other things. However it is suggested adults get about 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity exercise per week. Children should have one hour of physical activity (this could just include walking or running) every day, plus muscle-strengthening and bone-strengthening exercise about three times a week (sports). Younger children don't necessarily need structured exercise programs, but the appropriate age to start that would be when they are tweens or teenagers.

Another important part of staying healthy is going outside. Since screens can be so addicting, it may be hard for people to get off their screen and do something useful like going outside. But we really tend to overlook the importance of going outside. For one, going on a run outside is a great way of getting exercise, which we just talked about. Even just walking is good to get your heart rate up, and it's much better than laying on a bed in front of a screen. Remember your circadian rhythm? Sunlight sends a signal to the cells in your eyes and tells it that it's daytime, which, as you learned earlier, is vital in order to get enough sleep. Going outside can also help your immune system, because sunlight energizes a certain cell in your immune system called a T cell (it's what helps you fight an infection). Not only that, but some plants even release a certain compound called phytoncide. This means "exterminated by the plant", as its purpose is to protect trees and plants from harmful germs or insects. It actually also helps boost our immune function. There is also a key vitamin that you get from the sun called Vitamin D. It's good for your body in a lot of ways: it strengthens your bones, muscles and immune system, helps you get more sleep, and a lot more. So really try to get outside as much as you can, it is important for your mind and body.

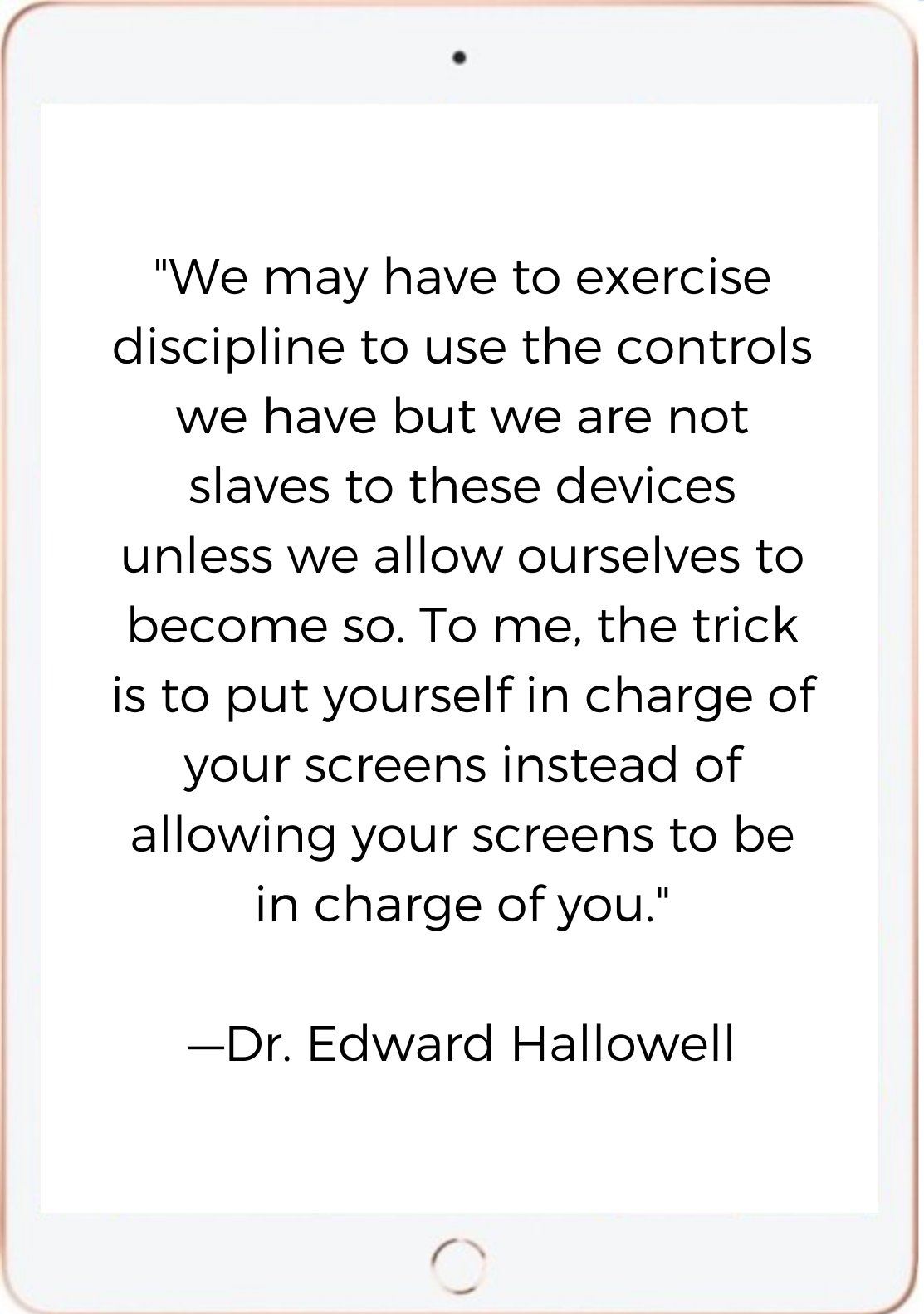
Eating and sleeping are both affected greatly by screens, but do they have anything to do with each other? The answer is yes. Getting enough sleep is also important to maintain a healthy weight and control your eating. When you sleep, the amount of leptin in your body increases, since you are conserving energy and don't need to burn calories (remember, leptin is what controls our energy). But if you don't get enough sleep, your body doesn't produce enough leptin and your brain sends a message to your body. "Oh, there's not that much leptin, guys. We're not full, so let's eat!" it says. This results in you wanting to eat, even if you don't need to. Sleep also affects ghrelin. Sleeping lowers the amount of ghrelin, but that changes if you don't sleep enough. Ghrelin levels increase when you're still awake, so naturally you will still feel hungry if you don't get enough sleep. This plays a trick on your body and tells it that it doesn't have enough calories, therefore stopping the production of calories. Yeah, sleep deprivation and hunger probably were more intertwined than you thought, right? But it doesn't stop there. Lack of sleep also causes an increase in some stress hormones, as well as insulin resistance. So making sure you get enough sleep also makes sure that you eat a healthy amount of food.

But what happens if you have too much ghrelin or too little leptin? An extremely uncommon condition that is caused by low levels of leptin is called congenital leptin deficiency. People who have this condition basically can't produce leptin. There are fewer than 30 people that have congenital leptin deficiency (on record). Yeah, it's a tiny amount. Since their body is unable to produce any leptin, their brain thinks it does not have any fat at all, so the person ends up eating uncontrollably. But that is such a rare disease, so it's not really relevant.

Now let's talk about high levels of ghrelin. Usually lean people have the most ghrelin in their bodies, as they have less body fat, although there is one disease that can be caused by high levels of ghrelin where that is not the case. People with obesity have very low levels of ghrelin, but for people with Prader-Willi Syndrome it's the opposite. This genetic disease is found in people with high levels of ghrelin, but it is actually similar to obesity, surprisingly enough. The people with this disease have severe obesity, although they likely already had high levels of ghrelin before they developed obesity. Another unfortunate result of Prader-Willi Syndrome is learning problems or trouble taking in information.

Now, just know that all of these are very extreme conditions and not very common. There is no need to worry; Prader-Willi Syndrome only occurs in about every one in 15,000 births while, like I said earlier, only about 30 people have congenital leptin deficiency. Although everything I said is true, and you should always be cautious. This is just another reason to take your screen time seriously.





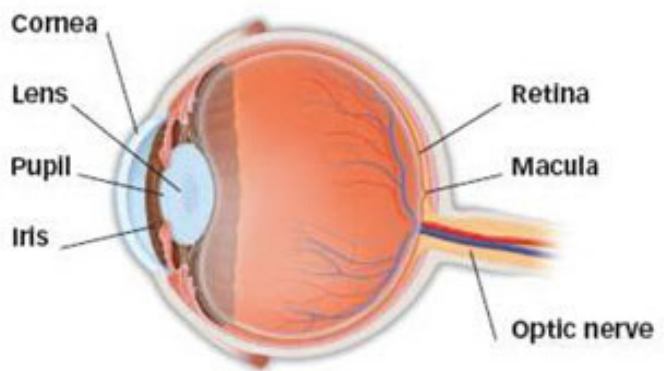
"We may have to exercise discipline to use the controls we have but we are not slaves to these devices unless we allow ourselves to become so. To me, the trick is to put yourself in charge of your screens instead of allowing your screens to be in charge of you."

—Dr. Edward Hallowell

SMALLER PROBLEMS

EYES

Those were just a few ways that screens can affect your physical health, and they can also cause some smaller or overlooked problems that build up over time. Although we are around blue light all the time, staring at a screen right before bed can have some serious side-effects. An example of things people tend to not pay as much attention to are eye problems, which are extremely common. I will quickly explain how light passes through our eyes. Many people refer to the eye as a camera, and the two are actually more similar than you might think.



A camera works like this: the lens in the front of a camera allows the light to come in and focuses it on the film. The picture forms when the light hits the film. An eye isn't much different. The lenses on our eyes are usually clear (unless the person has some sort of eye problem), and they let the light enter our eyes. The cornea is a clear part of the eye that covers the iris, pupil, and anterior chamber (a section of the eye filled with a water-like substance between the cornea and iris). Along with the lens and anterior chamber, the cornea refracts the light in a way that focuses the light onto something called the retina. The retina is basically a thin layer of tissue near the optic nerve in the back of the eye. It acts as the film in the camera metaphor. When the light is focused onto the retina, cells inside it turn those light signals into electrical signals and send them through the optic nerve and to the brain. The brain processes those signals into what we see all around us. It's a pretty cool system. Above is a map of the eye to give you a better sense of what I am talking about. Now that you understand the basics of how an eye works, we can move on to some of the problems that can be caused by screens. The most common eye problem is called digital eye strain. Roughly 60% of Americans that use screens have digital eye strain, and it can be caused by many things. Bad posture, improper lighting (i.e. a dark room), the glare of the screen itself, putting the screen too close to your face, among other things can cause this common eye problem. The symptoms are usually headaches, dry eyes, sore neck or shoulders, and blurry vision. As you can see, there are just so many things that could cause digital eye strain, which is likely why it's so common.

Top picture: without AMD
Bottom picture: with AMD



Another eye problem that is caused by blue light is called macular degeneration or AMD for age-related macular degeneration (look at the map of the eye to see the macula). With this incurable eye disease, the macula gets worn down and you lose your central vision. Central vision is what makes you able to see small details, however people that have macular degeneration have the same ability to use their peripheral vision as those who don't. There are two types of AMD: dry and wet. Dry AMD is the most common type, about 80% of people with AMD have the dry form. Dry macular degeneration is when yellow deposits called drusen form in the macula (yellow deposits are made out of liquids and protein) and they grow over time, distorting your vision. Those light-sensitive cells I was talking about are in the macula and they're called photoreceptors. Dry AMD causes the photoreceptors to thin out and then die. Wet AMD is a lot less common but a lot more serious. This is when new blood vessels grow under your retina and possibly leak blood or other sorts of liquids. This form of AMD causes vision loss to develop in the person faster than it does with the dry kind. Now, how do screens play a part in causing this eye problem? Let me tell you about macular pigment first. Macular pigment lives in your macula, and its main purposes are to improve your ability to see small details and absorb the blue light so that it doesn't hit the photoreceptors. However, the macular pigment can only withstand blue light to a certain level. Eventually, the two main nutrients that make up macular pigment wear away, making it weaker and unable to block blue light from damaging the photoreceptors. These low levels of macular pigment are a leading cause of AMD and vision loss.

An article from The University of Toledo says that blue light from screens can turn certain molecules in the retina into “cell killers”. It says that it’s evident that blue light harms our sight by damaging the retina, and that the cornea and lens can’t block or reflect it. Earlier I said that macular degeneration causes the photoreceptors in the retina to die. The photoreceptors themselves need a molecule called retinal in order to pick up the light and send the signals through the optic nerve and to the brain. The article explains that Dr. Ajith Karunaratne, an assistant professor in the University of Toledo Department of Chemistry and Biochemistry, supposedly found that exposure to blue light makes the retinal cause reactions in the eye that create chemical molecules in photoreceptor cells. A member of her team says, “It’s toxic. If you shine blue light on retinal, the retinal kills photoreceptor cells as the signaling molecule on the membrane dissolves. Photoreceptor cells do not regenerate in the eye. When they’re dead, they’re dead for good.”

Karunaratne tested her theory by introducing retinal to other cells in the body like cancer cells, heart cells, and neurons. When blue light came into the mix, the same thing happened as it did with the photoreceptor cells. But nothing happened with just blue light or just retinal. They used the same process of shining the light on the retinal with green, yellow, and red light and didn’t get the same results. Nothing happened. The team found that there was a molecule, alpha tocopherol, that could stop the chemical reaction and prevent the cells from dying. This molecule comes from vitamin E, and it’s a natural antioxidant in the eye and body. But as a person gets older (or the immune system gets weaker) they lose the ability to fight the reaction.

The lab is currently measuring the light that comes from display devices (TVs, phones, tablets) to better understand how the cells in our eyes respond to everyday exposure to blue light. They say that the amount of light coming out of cell phones seem tolerable, but they support the fact that some companies are adding blue light filters to their phones.

Dr. Karunaratne says, “By learning more about the mechanisms of blindness in search of a method to intercept toxic reactions caused by the combination of retinal and blue light, we hope to find a way to protect the vision of children growing up in a high-tech world.”

Now that you know about AMD, we’ll move on to retinal damage, another common eye problem. As a matter of fact, macular degeneration is the leading cause of retinal damage. Like I said before, the retina is a very thin, light-sensitive tissue in the back of your eye. There are many symptoms that come with this issue such as “dim vision”. This is caused by the lack of cells whose job is to help process the light around us. When you have dim vision, everything around you looks darker and the colors sort of bleed together, or you just have trouble making out the different colors. But that is just one of the many symptoms like flashing lights, double vision, distorted vision, dots or lines that cloud your sight, and blind spots.

JOINTS

But there is also a completely different side of the spectrum that is affected by screens. That would be your joints. This might seem like a weird statement. How could screens affect your joints? Well instead of blue light being to blame here, it's the actual devices themselves.

You might be surprised at how much damage even just typing a few sentences on a phone could do. For example, take de Quervain's syndrome. This is the damage of the tendons in our thumbs that control its movement. It's caused by repetitive movements, such as texting. That's why this syndrome is also called texting thumb. Just a small thing that we are so used to doing can turn out as a serious tendon issue. But there's more.

Even just holding the phone can cause problems. Typing is the real issue, however. See, people actually hit the virtual keys on a phone about eight times harder than they would if they were using a computer with actual keys. This puts strain on the wrists, forearm, and fingers. People also hover their fingers over the phone in anticipation of typing, which is an action known as isometric tension. Isometric tension is just a part of an isometric contraction. This is caused when the muscles are activated but are held in the same spot for a longer period of time, such as hovering your fingers over a phone. Carpal tunnel syndrome can be caused by unnatural positions like hovering, and the symptoms are pain, numbness, and tingling in your fingers (typically your thumb, index finger, middle finger, and part of your ring finger).

Hanging your head at a **60 degree angle** puts **60 pounds of pressure** on your neck!

Now comes the spine. When we hold phones (or other devices, but that's a slightly different matter), we hang our necks to look down at the screen. That may seem okay, but it's actually very harmful to our spines and necks, two extremely important parts of our bodies. In fact, hanging your head at a 60 degree angle puts 60 pounds of pressure on your neck! At the bottom of the page is a picture that shows the amount of pressure put on your neck based on the degree your head is tilted at.

Large amounts of pressure on your neck like that can cause posture issues by contorting your spine. That's why it's extremely important to think about your posture whenever you are using a device.



The amount of pressure put on your neck based on the degree your head is tilted at (in pounds).

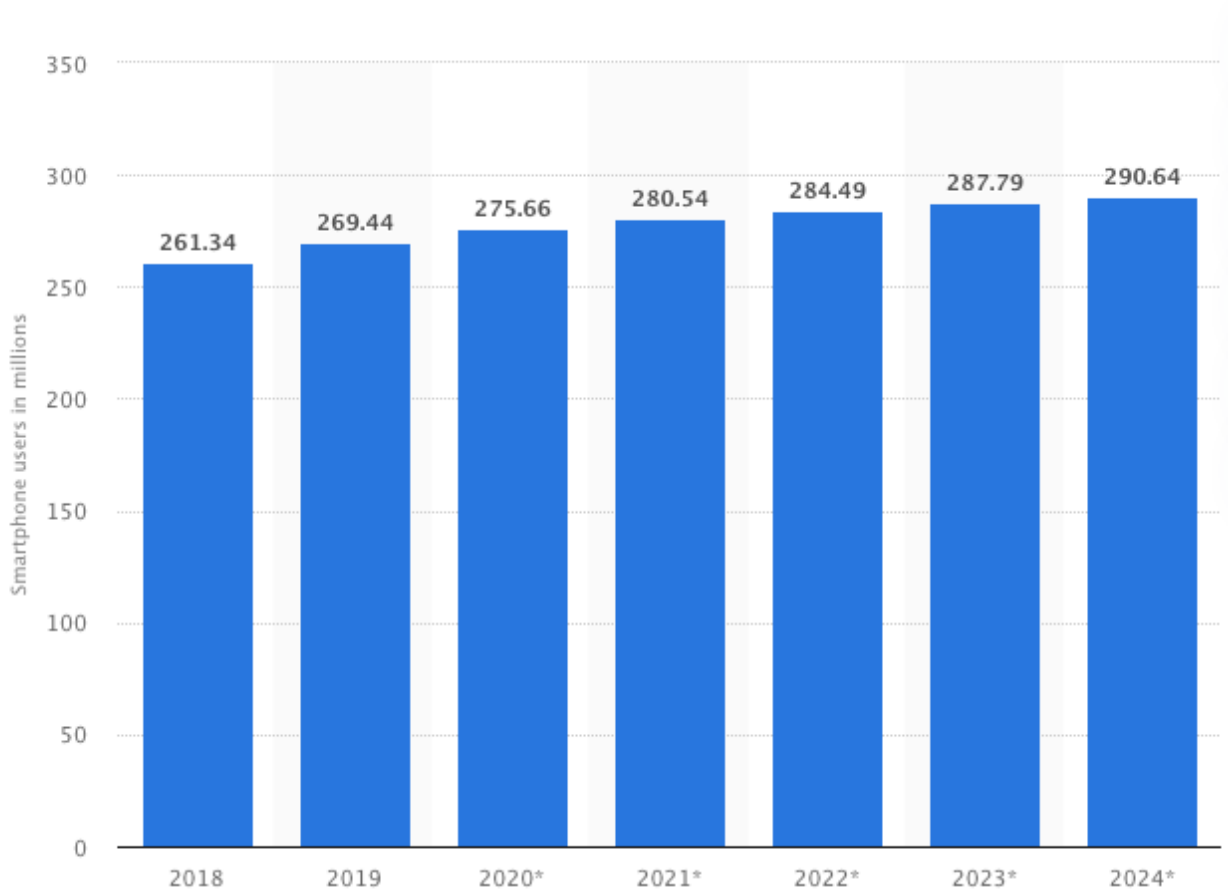
This leads me to talk about ergonomics, and how to stay safe by using good posture and healthy positions. The Google definition of ergonomics is “the study of people’s efficiency in their working environment”. Ergonomics is basically fitting a workspace to the needs of the person or people who live in it. You might be wondering why that’s important. Being stuck at a desk working for long periods of time is very uncomfortable, and in order for the things I mentioned above not to happen, you have to be mindful about your working environment. Although the joint problems I have explained earlier are more related to using a phone, there are still many problems that can occur when using a computer. Back and neck pains can still happen from hunching over a computer. Even furniture comes into play in ergonomics. Sitting down may be easier than standing up, but it reduces the circulation to your tendons, joints, muscles, etc. This also causes stiffness and pain.

So what can you do to prevent all these problems from happening? I’ll explain more about ergonomics and what you can do to avoid this in Part 8: How Can I Avoid These Problems?



The number of smartphone users in the U.S. (in millions) from 2018 to 2024. The asterisks mean that the numbers are estimates for the future.

Source: Statistica



THE IMPACT OF SOCIAL MEDIA



Now, I just explained most ways blue light can have an impact on your physical health, but it can also take a big toll on your mental health too. As you probably know, social media is a huge problem in the mental health part of things. Social media may be a great way to communicate with people from all over the world, but sometimes people never think of all the bad things that come from using a lot of social media. This section will explain how social media is affecting our mental health and why.

Studies have shown that people who spend a lot of time on social media have a much higher chance of getting depression or anxiety. A study funded by the U.S. National Institutes of Health involved about 1,800 people and tracked their usage of 11 social media platforms: Facebook, Instagram, YouTube, Twitter, Reddit, Snapchat, Tumblr, Pinterest, and LinkedIn. The purpose of the study was to find out how connected social media usage and depression are linked. They found that the participants checked some or all of these social media apps an average of 30 times per week for over an hour per day. They all took tests to determine whether or not they had depression, and the results showed that about one fourth of the participants had a very high chance of having depression. The researchers determined that the people who used social media the most were roughly 2.7 times more likely to have depression than those who used the apps less frequently.

But what makes using social media cause depression? First, people who spend most or all of their time on social media are not spending enough time with actual people. They are talking to more people online rather than in real life. Since we are social beings that thrive with other people around us, isolating yourself and focusing more on online relationships is not healthy. And staying on a screen in all your free time means not having as many real life experiences either. I mean think about it, there are so many more things you could be doing than spending all your time on social media.

"The other area of behavior that we know of is social interactions. So when people are spending too much time in front of screens, they're cutting down the amount of time they would spend talking to someone and engage in social interactions. And we know for kids that it's really important for their brain development to be having face-to-face interactions with their family, with their friends, and with their teachers. And so if someone is spending too much time in front of a screen, it cuts down in the face-to-face interactions."

—Dr. Kaplan



The next thing I will talk about is FOMO, or Fear Of Missing Out. Most people or “influencers” only project their positive experiences, and even those are edited to paint the perfect picture. When you open up a social media app, the first thing you’ll usually see is a picture of some sort of celebration or “fun outing” with friends. Not many people on Instagram post things about something negative or something that could make them look bad. This is what is often referred to as the highlight reel. Outsiders who are viewing this content might think that they are not living their best lives, or like they are missing out. Some people are jealous of these moments if they think that their life is boring, or if they are going through a tough time. People don’t want to miss out on fun activities, adventures, events, etc. This is what’s known as FOMO.

Another huge thing that could affect your mental health is cyberbullying. In case you don’t know, cyberbullying is the act of bullying someone online, or in “cyberspace”. This is very common, since a lot of people think bullying someone online is easier than in person. And in this situation, there’s not really an escape. Since phones and social media are so common in modern society, it’s so easy to find a random person (or choose someone purposefully) to bully online. In the physical world, it’s much easier to escape bullying by asking someone for help, or literally escaping. But online, there aren’t many options. A person can find you very easily through social media, or even hacking if it comes to that. And whenever you’re on a device, the person can get in touch with you.

This is a very common problem; let me give you some statistics. In 2011, about 2.2 million Americans were cyberbullied in some way. From 2013 to 2014, it was estimated that 7% of students in the 6-12th grade and 15% of high schoolers experienced this. That’s a LOT, even though it might not seem like it.

Cyberbullying has a lot of effects on people. Children have been shown to react in many different ways: skipping school or they're just not willing to go to school, substance abuse (like drugs), problems with mental health, trouble keeping up in school, low self-esteem, and higher chances of being bullied in real life are just a few ways cyberbullying can affect a child. And sometimes these things can even stick with a person throughout their life.

Another way social media has been hurting people's health is by causing eating disorders. When you look at social media pictures, many of them are edited to make the person look something like "a skinny legend". That doesn't stop people from comparing themselves to these edited pictures. People will tell themselves, "I don't have any muscles. I'm not skinny enough. I'm too fat."

This makes many people inclined to lose more weight. While that's not always a bad thing, some people take it to the next level, a very unhealthy level. If you don't know what an eating disorder is, it's basically when a person has a certain image in their head of what they want their body to look like and go to extreme measures to look that way. There are many different types of eating disorders, but all of them are characterized by a person wanting to eat less, or even starve themselves in order to be skinny. One of the most common eating disorders is called anorexia nervosa, or just anorexia. People with anorexia go to the extremes to limit their food intake. Many people purposefully vomit after every time they eat something. They may also exercise excessively, to the point where they are overworking themselves. It's been shown that females are more likely to develop eating disorders such as anorexia, specifically teen girls between the ages of 15 and 18. But anyone can have problems like eating disorders or depression.

Websites

Facebook.com

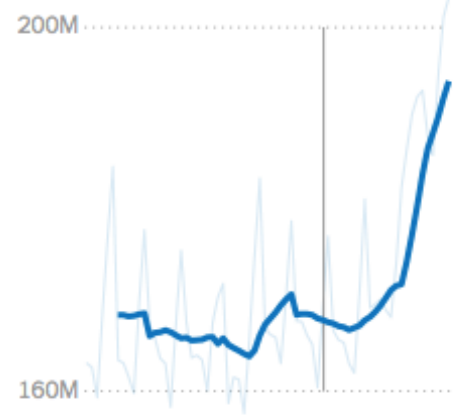
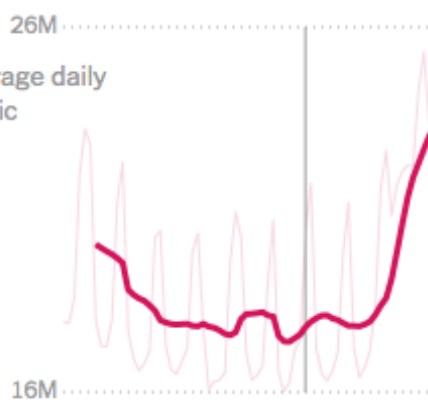
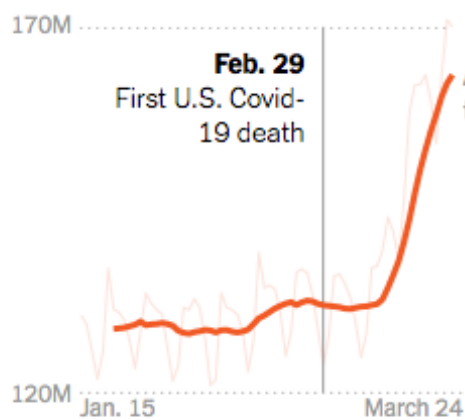
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Netflix.com

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YouTube.com

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Apps

Facebook

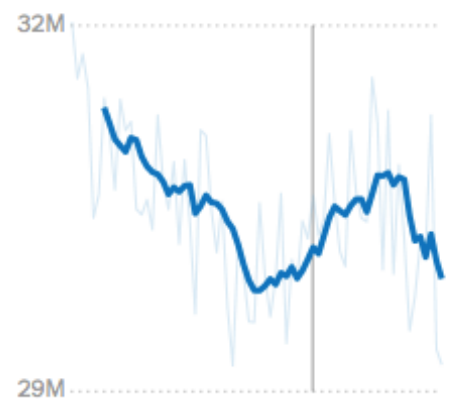
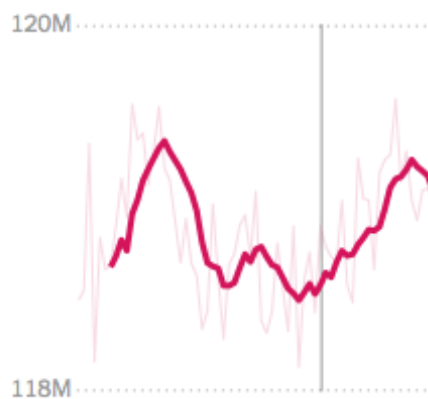
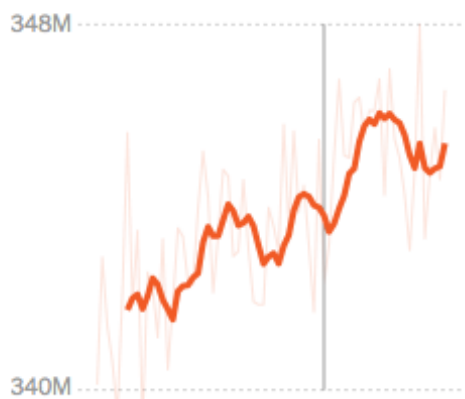
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Netflix

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YouTube

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The average usage of streaming services and social media before and after the first U.S. COVID-19 death. This data was recorded from January 21 to March 24.

Source: The New York Times

HOW CAN I AVOID THESE PROBLEMS?

So after learning all of that, you might be wondering, “How can I keep myself safe and prevent these things from happening to me?” Well, there are a lot of things you can do to avoid all of these problems.

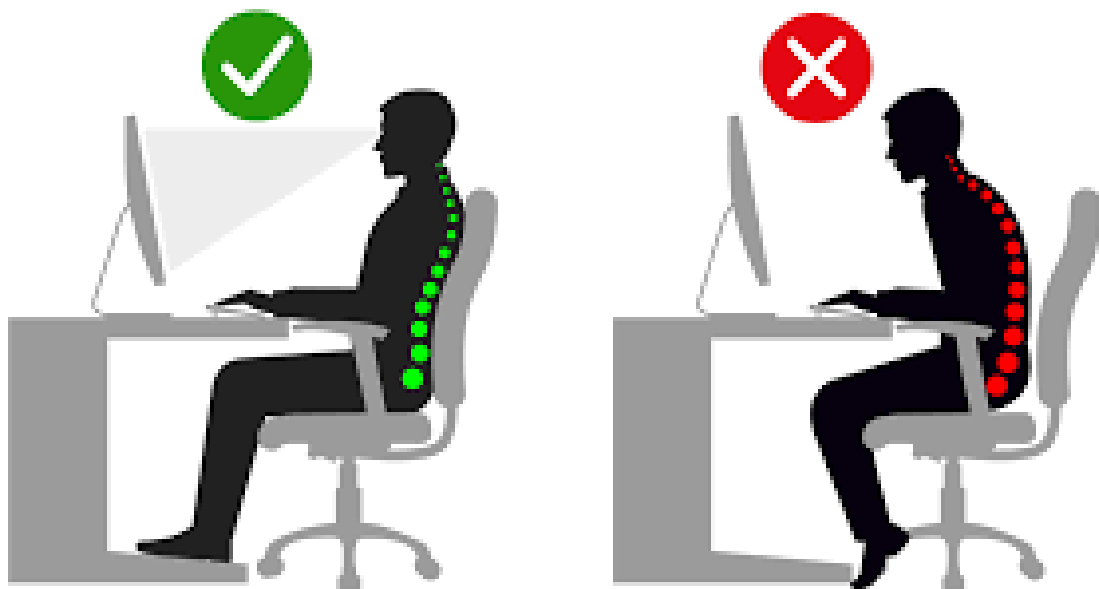
The first and most obvious one would be to regulate your screen time. I've been talking on and on about how staying on a screen for a long time can be so harmful, so make sure to be mindful about how much time you spend on a screen. There are lots of apps to monitor your screen time and help set restrictions, such as Screen Time for iPhones and iPads. Screen Time tells you lots of things like how much time you spend on a screen in a week, the average screen time, and how much time you spent on your phone that day. You can set restrictions on certain apps. For example, you could regulate the time you spend on Netflix to half an hour, and once that half hour is up, it will notify you. You should also put your screens away before bed. It is advised that you don't go on your screen from 30 minutes to an hour before your bedtime. But sometimes setting boundaries isn't enough.

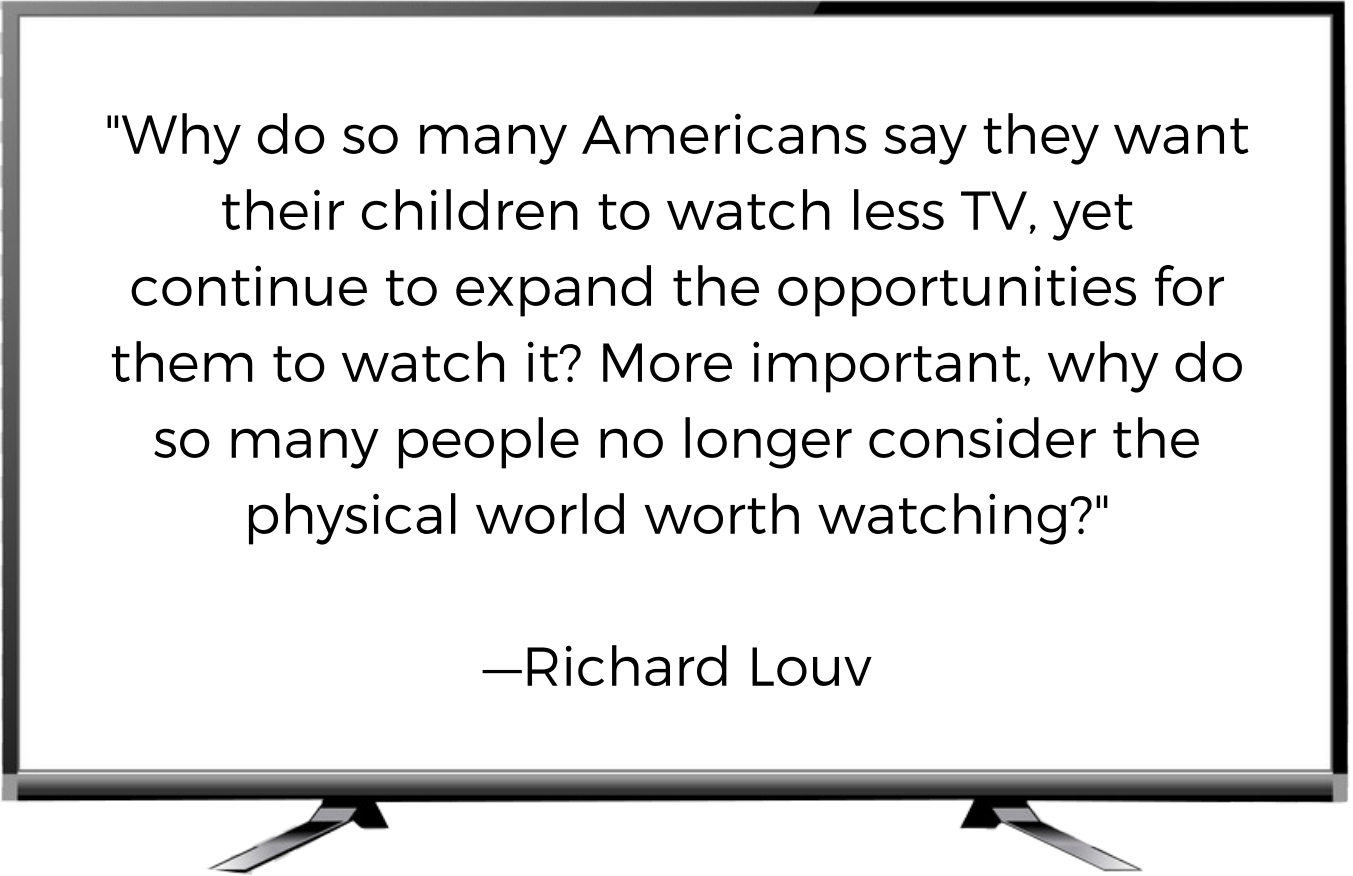
That leads me to talk about filters. Almost all screens have some sort of app or function that allows you to put a filter to block out most of the blue light. These don't completely block the blue light, but they lower the concentration so it's not as hard on your eyes, and the blue light has less of an effect on your body. Some of these filter apps include f.lux (for a MacBook computer) and Night Shift (for an iPhone or iPad). But there are also things called blue light glasses, which are blue light filters but for glasses (you can get these with a prescription if you wear glasses or without if you don't).

Another thing you should always be doing is taking breaks. One very common rule that my eye doctor suggested to me is called the 20-20-20 rule. In this method, every 20 minutes you look 20 feet away for 20 seconds. This is very effective, as it gives your eyes a time to relax, even if it's just for 20 seconds. But you can also obviously take breaks without using this rule. Even just walking around or getting water every once in a while is good enough. Also, remember to blink! That might sound weird, but when people use screens they blink a lot less than they do if they're not on a screen. This is important, because your eyes can dry out really easily if you don't blink.

Another part of this is distance. You should keep the screen about 20 to 25 inches away from your face (this mostly applies to computers) so that the light is less brutal and is minimized. A lot of people keep their computers pretty close to their face, especially if they're not sitting in a comfortable position.

That brings me to ergonomics. Earlier I was explaining what they were, so now I will tell you what you can do (most of these only apply if you are using a computer). You should keep your head from hanging low, but you don't want to be leaning it back. This supports the neck and spine; remember, hanging your head at 60 degrees puts 60 pounds of pressure on your neck. Your arms should be close to a 90 degree angle, or just so that they're not scrunched in, but not stretched out too far. Keep your feet flat on the floor so they're not pointed or dangling off the edge of the chair or whatever you're sitting on. All of this might seem unnecessary or uncomfortable, but just remember all of the bad things that can happen if you don't follow these guidelines. It'll be good for you in the long run.





"Why do so many Americans say they want their children to watch less TV, yet continue to expand the opportunities for them to watch it? More important, why do so many people no longer consider the physical world worth watching?"

—Richard Louv

REFLECTION QUESTIONS

A section that includes a few
questions to help you reflect on
your personal screen time

**How long do you
usually spend on a
screen per day?**

**What would you be
worried about if you
couldn't use your
screen for a day?**

**What apps do you find
yourself using the
most?**

**What do you think
would be the most
effective way to get
yourself off a screen,
even for just an hour?**

CONCLUSION

This whole eBook has been about how screens can harm us, mainly because of blue light, but let me tell you some of the positive sides to blue light. Yes, blue light isn't all bad. Science has shown that a little bit of blue light exposure can be good for you. It can help with alertness, memory, and even mood. Remember, it controls the circadian rhythm too. It is vital in order to maintain a healthy sleep schedule. You just have to be careful not to use screens at night so that the blue light doesn't disrupt your sleep. And blue light is in the sun as well, so it's a very important part of regulating energy.

Whenever you use a screen, remember the things I have told you in this report. Be mindful of your screen time and how you use screens in your daily life. Humans have become very dependent on screens in this modern society, but that's not completely bad. We just have to be careful of our screen-usage, and educate ourselves on the ways screens can impact our minds, bodies, and lives in general.