Essay 1
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Light Has a Dark Side?

It is getting late and you have a big day tomorrow. You will need to be up early for work and even earlier if you decide to fit in that 5:00AM workout. You really should go to bed, but maybe you'll just scroll through your Buzzfeed until you fall asleep.

Before you know it, it has been over an hour and you still are not in bed. In fact, now, you are not even tired. Instead, you are starting at your phone. You come across an article titled "Your Phone is Ruining Your Sleep" and you proceed to read on about how the light emitted from your phone inhibits your sleep, keeping you up at night. *Well, there you go* you think. *My night's sleep is destroyed.*

Is it really destroyed though? Sure, you are not tired and this article you are reading makes your phone's light sound like the culprit. However, is it really the light itself that is keeping you from falling asleep? Could there be other factors involved, or is light emitted from technology actually as bad as the media portrays it to be? The lack of answers to these questions have prompted scientists and doctors to expand their research, and their findings prove to bring contradiction to today's internet articles and LED light-blocking glasses. The reality is that, when comparing scientific studies to common concerns and conceptions, the light emitted from technology may not be as bad as it sounds. In fact, there may be other factors causing a lack of tiredness that have nothing to do with the brightness of your screen.

So why is this negative impression existent in today's media? Why is light from technology targeted specifically? To bring about answers to these questions, we must examine the science and history of light and the actual scientific evidence found on light and its impact on sleep.

Color of Light

Each form of light is categorized on a color spectrum. On this color spectrum are three main categories: red, green, and blue. Therefore, when light is emitted from any source, artificial or natural, it is classified as either green light, red light, or blue light. While green and red light have been found to not be as impactful on one's sleep cycle, blue light is known to have more effects on the alertness of an organism exposed to it. However, this does not make blue light inherently bad, as the sun is actually the largest source of blue light known to man. So, if humans have been exposed to blue light long before technology, why is blue light portrayed so negatively in the media?

Articles and awareness about the light emitted from technology have been populating the internet more and more within the last three years. Many websites claim that viewing your phone or laptop before bed can keep you up for three hours or that blue light from your TV could

be blinding you. These websites and articles are putting technology user's guards up, and many people now try to avoid technology use an hour or two before bed.

So where did this start? While the concern about blue light has only recently reappeared, it was actually first studied back in the 1960s.

History

The concern about blue light in technology and the potential damaging effects it could have on the human eye has been on the rise for the last few years. This growing concern may have been due to the revival of J. Woodland Hastings' and Beatrice M. Sweeney's original blue light study[3] that tested the various abilities of different wavelengths of light. In this study, they found blue light to shift the circadian rhythm, or internal clock, in marine microorganisms. The study also helped to connect this link to the circadian rhythm in humans, as the sun was discovered to be the greatest source of blue light on earth. Since the presence of blue light tends to suppress one's melatonin levels, this finding explained why humans naturally operate on a circadian rhythm of sleeping when the sun sets and waking when the sun rises.

In the 1960s this finding, while interesting, did not impact people's thoughts about blue light. A recent article produced by Medscape[6] explains this by stating that "historically, people have gone to bed when the sun sets and risen with the sun. With the absence of technology and artificial lighting, there was just nothing to do once the sunlight was gone. Everyone went to bed earlier and got up earlier and everyone had the same internal clock.[6]" However, with the rise of technology and artificial lighting in today's world, people have more reasons to stay awake longer at night than they did before.

In 2007, J. Woodland Hastings' and Beatrice M. Sweeney's original blue light study[3] was revived and looked at once again due to the rising amount of sleep inhibiting conditions in patients. At that time, more was known about blue light and its effects, yet how it specifically effected humans was still a mystery. The revival of this study[3] launched into several years of insomniac patient habit studies as well as studies on the circadian rhythm in humans with and without blue light. After nearly three years of research, the overall consensus was that exposure to blue light within one to three hours before bed can alter one's circadian rhythm and melatonin production. This can make it difficult to fall asleep, to stay asleep, or to get a proper amount of NREM, or deep sleep. The damages and strain placed on the eyes due to computer and technology use was also examined and it was determined that overexposure blue light can potentially cause damages to the eyes over time.

As a result of these findings, warning articles regarding the topic flooded the internet. Articles titled "Blue Light is Destroying Your Eyes[8]" or "Your Phone Might be Making You Blind[9]" captured the interest and concern of readers, and, thus, the negative reputation of blue light was conceptualized. Since these articles, certain products and measures have been created

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3.Sweeney, Beatrice M., and J. Woodland Hastings. "Rhythmic Cell Division in Populations Of Gonyaulax Polyedra" *The Journal of Protozoology*5, (June 9, 1959): 217-244.

6.Harrison, Laird. "Is 'Blue Light' Really That Bad for Us?" Medscape. April 23, 2018.

8.4greatvision. "Blue Light Is Destroying Your Eyes." Dr. Facchiano and Associates, PC.

9.Hughes, Calvin. "Your Phone Might Be Making You Blind." Civilized. August 17, 2018.

to supposedly protect technology user from blue light and its "deathly effects." iPhone released a new widget that was designed to alter the type of light your phone's screen emits, changing the light color spectrum from blue to a red. Android released a similar widget and suddenly apps performing these functions appeared in the App Store and in the Google Play Store. This trend continued to repeat itself in the eyewear industry, as specialized contacts and glasses designed to protect eyes from blue light emissions now exist. In addition to the concern shown in the media, the warning has also been spread to families. In a recent survey produced by *The World Journal of Biological Psychiatry*,[1] sixty percent of parental participants said that they do not allow their children to use technology up to one hour before bedtime. Additionally, twenty-five percent of teen parents interviewed stated that they no longer allow technology in the bedroom at night because they have heard the blue light emissions can still be potent even if the technology is in sleep mode or charging.

So, what does this mean for your pre-sleep Netflix binge? Should you invest in $80 glasses and minimize technology use? Well luckily scientists are digging into that question, as they work to find out just what keeps us up at night and how much it may or may not have to do with our technology.

Scientific Research vs The Media

When comparing the articles on the web to actual research findings, the majority of articles are shown to exaggerate to the extremes. For example, the article titled "Your Phone Might be Making You Blind[9]" claims to cite *The World Journal of Biological Psychiatry*[1] as its primary source. However, when looking at the raw study data produced by the journal, the study results themselves show minimal negative effects of blue light in human sleep, and absolutely no scientific evidence pointing towards blindness caused by blue light. This type of exaggeration is commonly found in online articles regarding blue light. Another recent article titled "Blue Light Is Destroying Your Eyes,[8]" claimed to cite Sweeney's and Hasting's original study.[3] The article refers to the study, and then goes onto state how the study proves that blue light can damage the human eye when, in reality, the original study was not even performed on human subjects. Articles such as those described, while a commonplace on the internet, are not to be regarded as truth when it comes to the actual impacts of blue light.

Since this contradiction is present in many of the articles on blue light, the real impacts of blue light are not commonly known. The internet is telling people to be concerned about blue light, yet studies have a different story to tell.

Sweeny' and Hastings' Light Spectrum Study

Looking at Sweeney's and Hastings' original study[3], the findings do report blue light as having a more significant impact on the circadian rhythm of marine microorganisms. However, the difference in the effect caused by blue light and red light is less than twenty percent and even less than green light, which was shown to be just under fifteen percent. In addition, this study

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1.Bauer, M. "The Potential Influence of LED Lighting on Mental Illness." *The World Journal of Biological Psychiatry*18, (July 07, 2018): 59-73.

3.Sweeney, Beatrice M., and J. Woodland Hastings. "Rhythmic Cell Division in Populations Of Gonyaulax Polyedra" *The Journal of Protozoology*5, (June 9, 1959): 217-244.

8.4greatvision. "Blue Light Is Destroying Your Eyes." Dr. Facchiano and Associates, PC.

9.Hughes, Calvin. "Your Phone Might Be Making You Blind." Civilized. August 17, 2018.

was performed using harnessed natural light, or sunlight, which emits nearly sixty percent more blue light than the average cell phone today[1]. This being the case, the differences seen between the various light types in the study would be even less if the blue light were to be coming from a cell phone or similar technology.

This fact alone alleviates some of the hate on blue light from cell phones as an exclusive culprit for bad sleep patterns. However, it does not address the issue that blue light itself, despite its color spectrum can affect the circadian rhythm in humans. One of few credible online secondary articles titled "Is 'Blue Light Really That Bad for Us?" covers this topic, as it describes how artificial lighting has moved more towards blue light in recent years. The articles explain that the blue light range falls between 300nm and 500nm, and that the majority of modern LED lights fall within this range. The articles stated that the human eye is designed to more easily block light that produces greater than 550nm, and, therefore, our eye blocks light from the red and green color spectrums more easily. This explains why blue light is able to impact the circadian rhythm more than light of other color spectrums, but the article also stated that overexposure to lights of other color spectrums can have just as much effect on the circadian rhythm in humans. "Sitting next to a bright light for an extended period of time, even if it is not considered blue light can still impact your internal clock," the article stated. The article ended stating that even when light does impact the circadian rhythm, it has never been shown to alter by more than ten percent.

In comparing the results of this study to the major headlines heading warning about blue light, the articles on the internet are proven to be major exaggerations. Comments such as "your phone light could keep you up for three hours," or "$80 glasses protect from dangerous, unnatural, blue light" simply are not backed with scientific evidence. According to this research, blue light in itself is not inherently bad or unnatural as, in its greatest form, it comes from the sun. As a result, your exposure to the sun during the day can alter how much artificial light will impact your sleep. Those that spend much of their time in the sun will feel little impact from sitting in a well-lit room before bedtime, whereas those who work in indoor or darker work environments may feel this makes more of a difference. In addition, it's not only LED blue-lit technology that is to blame, considering all colors of light play an impact in keeping the human body alert.

The Journal of Psychiatric Research Sleep Study

The previous study confirmed that blue light only has minimal effects on sleep and that other light forms can have an impact as well. However, while this is starting to look good for technology users, the time and quality of sleep must still be tested. In addition to this, one might also wonder if the type of technology use taking place before bed may carry weight in the blue light – sleep equation.

In two recent sleep studies conducted by *the Journal of Psychiatric Research*[2], the time and quality of sleep with and without blue light was examined. The first study was a sleep study

1.Bauer, M. "The Potential Influence of LED Lighting on Mental Illness." *The World Journal of Biological Psychiatry*18, (July 07, 2018): 59-73.
2.Jung-Yoon, "Effects of Smartphone Use with and without Blue Light at Night in Healthy Adults: A Randomized, Double-blind, Cross-over, Placebo-controlled Comparison." *Journal of Psychiatric Research (December 9, 2016): 60-70.*

consisting of two different groups: a group that was allowed to have technology and a group that was not allowed to have technology before bed. Participants were instructed to attempt sleep at a normal bedtime for them following their hour of technology use or their hour of no technology. A select group of the participants had been previously diagnosed with sleep conditions, and they were dispersed evenly amongst the two different groups. After the study, the results appeared to show little difference between the sleep of the two groups. Of the participants that showed no trouble falling asleep, those who had used technology within an hour before bed showed to have gotten only ten to fifteen minutes less sleep than those who had not used technology. In addition, technology-using participants were shown to be in NREM, or deep sleep, for only five to ten minutes less than their non-technology using counterparts. Jung-Yoon, a researcher and sleep specialist stated that this small of a difference would not affect a human's alertness or physical well-being throughout the day. "Blue light from technology does impact the circadian rhythm in humans, but its impact is so insignificant that people may tend to lose more sleep over worrying about blue light than they would actually spending an hour on their phone.[2]"

In those individuals that did report difficulty falling asleep, the results were slightly different and there was a wider range of results. Participants in both groups claimed that they felt restless, anxious, and, simply not tired. With these symptoms considered, researchers on the team analyzed each participant's pre-study evaluation. In doing this, they found that over half of patients attempted to fall asleep before they were accustomed to going to bed. Therefore, they were attempting to manually adjust their circadian rhythm, which would affect their test results. The remaining participants that still had problems falling asleep were further analyzed. In this group, the difference between restlessness and a good night's sleep appeared to be found in the topic these participants were thinking about. While reviewing the activity logs of the participants using technology, the majority of them were found to be reading or researching medium to high stress topics, such as work, finances, or politics. This is a notable difference considering the activity logs of those who had fallen asleep easily mostly consisted of Netflix, YouTube, or eBooks. The same issue appeared to be present in those not using technology. The participants that had brought newspapers or magazines containing articles about similar, stressful topics had more difficulty falling asleep than those who read a book or sports article before bed.

So, what does this mean for those that enjoy using their phone right before bed? Honestly, not a lot. This study proved to once again show that blue light in itself makes such a small negative impact on sleep that the difference between using technology before bed and not should not really matter. If problems are still arising when it comes to sleeping, it may be time to examine what type of technology-related activities you are engaging in before bed. As the study mentioned, stressful, online activities such as intense research, taxes, or paperwork can keep some people up, whereas streaming Netflix may not. The opposite is also true for other individuals, so discernment may have to be used. As researcher Jung-Yoon stated, "it is time that people stopped blaming all of their problems on inhuman objects and started using their own judgment when it comes to basic necessities like sleep[2]."

Effectiveness Blue Light Blocking Devices

As discussed above, the media has played a huge role in the public's perception of blue

2.Jung-Yoon, "Effects of Smartphone Use with and without Blue Light at Night in Healthy Adults: A Randomized, Double-blind, Cross-over, Placebo-controlled Comparison." *Journal of Psychiatric Research (December 9, 2016): 60-70.*

light and how it works. Today, blue light and LED light blocking glasses and widgets are trending, but with the exaggeration that takes place in the media about the capabilities of blue light consumers should really check the facts before investing in such products.

A second study performed and published in the *Journal of Psychiatric Research*[2] studied the effectiveness of blue light blocking devices. In this study two groups of participants were also used: one group using technology bare-faced and without blue light blocking and one group that used blue light blocking devices such as glasses or device setting to change the color spectrum of the light being emitted. The results from this study showed even less difference between the two groups, with only twenty-percent of people experiencing a difference at all and those people only showing three to five minutes less of sleep. This study also showed that participants using blue light blockers remained in NREM sleep for the same amount of time as those who did not use the blocking devices. "What people do not understand is that any type of light exposure can keep you awake," stated researcher Jung-Yoon. "Just as the natural human eye may be unable to block out light completely, neither can blue-light blocking devices or any other type of light-blocking device." He goes onto state that when it comes to blocking light, individuals would get just as much protection from an average pair of sunglasses as they would if they paid $80 to buy special LED blocking lenses.

Based on the results of this study, it is really a marvel that such devices can remain successful on the market. Unfortunately, when it comes to academic scientific studies versus easy-access articles, the general public tends to devote more of its attention to the latter. Therefore, since the latter would like to make a profit, and the consumer would like to feel safe, products such as LED and blue light blocking glasses can remain successful on the market.

Long Term Damage

Aside from sleep, the other primary reason for such devices is the prevention of eye damage or permanent injury. Ever since Hastings' and Sweenys' original study mentioned that overexposure to blue light could cause long term damages or eye strain, the concern of actual permanent damage has been on the minds of consumers engaged in the topic. So how much exposure is actually considered overexposure and what kind of damage can actually occur?

JAMA Ophthalmol, a research facility that is centered around vision science produced a study[4] that analyzed blue light and UV rays and their beneficial and harmful impacts on human health. The study was primarily produced to address the possibility that blue light could harm the retina of the eye, eventually resulting in impaired vision or blindness[9]. The study examined both blue light emissions from common forms of technology and from sunlight, as they tested white mice under both conditions. The mice were divided into four groups: mice that were overexposed to UV rays from sunlight, mice that were overexposed to artificial blue light from

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2.Jung-Yoon, "Effects of Smartphone Use with and without Blue Light at Night in Healthy Adults: A Randomized, Double-blind, Cross-over, Placebo-controlled Comparison." *Journal of Psychiatric Research (December 9, 2016): 60-70.*

4.Williams KM, Association Between Myopia, Ultraviolet B Radiation Exposure, Serum VitaminD Concentrations, and Genetic Polymorphisms in Vitamin D Metabolic Pathways in a Multicountry European Study. *JAMA Ophthalmol.* 2017: 47–53.

9.Hughes, Calvin. "Your Phone Might Be Making You Blind." Civilized. August 17, 2018.

technology, mice that were exposed to the recommended amount of daily UV rays from sunlight for natural Vitamin D production, and mice that were exposed to the average forty-year old's usage of technology in the United States.

The mice that were overexposed to blue light from UV rays or technology experienced troubling injuries. Strained and bloodshot eyes, sunburn, peeling skin, and infection were all common side effects found on the mice. The mice who had experienced overexposure to UV rays had a higher rate of sunburn, infection, and peeling skin than the mice who had only been exposed to blue light from technology. These mice also showed symptoms of dehydration, and heat exhaustion. The mice who were overexposed to the blue light from technology showed more bloodshot eyes and eye strain symptoms than those of the UV ray only group, though the symptoms were not as severe.

The mice that received the recommended daily amount of UV rays from sunlight experienced little to no symptoms. The symptoms that were shown involved occasional restlessness and anxiousness. The researchers on the study identified this to a slight overexposure of sunlight, due to the fact that not as much is known about mice and their need for Vitamin D. The mice that experienced an average amount of exposure to blue light from technology showed little to no symptoms as well. No retina damage or pre-retina damage was seen in the mice. However, the mice did appear to be more active than mice that had previously been studied in dark.

The overall conclusion of this study was that overexposure to blue light in any form will cause harmful side effects, including retina damage. However, an appropriate amount of blue light balanced out by time away from blue light will not cause damage or harmful side effects. A web article produced based on the facts of this study confirmed this conclusion, stating that "there is no scientific evidence that blue light from the normal use of digital devices causes damage to your eye.[6]"

Blue Light and Mental Health

One final study attempted to understand the effects of blue light on mental health and sleep-related illnesses. This study analyzed the technology usage of patients suffering from mental illness. Out of the four hundred patients analyzed, eighty percent of them claimed to have difficulty falling asleep and staying asleep. Following this, their viewing history was examined. In over sixty percent of the patients, the viewing history included topics such as depression, anxiety, or other stressful topics. As seen in the *Journal of Psychiatric Research*[2] study discussed above, the topics viewed during technology use appear to have an impact on a patient's sleep. In fact, the overall conclusion of the study on mental illness concluded that difficulty falling asleep is more closely related to topics viewed or thought about before bed than blue light.

2.Jung-Yoon, "Effects of Smartphone Use with and without Blue Light at Night in Healthy Adults: A Randomized, Double-blind, Cross-over, Placebo-controlled Comparison." *Journal of Psychiatric Research (December 9, 2016): 60-70.*

6.Harrison, Laird. "Is 'Blue Light' Really That Bad for Us?" Medscape. April 23, 2018.

Scientific Results and Today's Concerns

The studies analyzed appear to all come to a general conclusion: blue light, while it does have the power to affect circadian rhythm or the "internal clock" of humans, its effects are insignificant and should not raise as much concern as they do. Participants using technology within an hour before bed still experienced a healthy amount of NREM sleep and sleep in general, with a difference of only fifteen minutes at the maximum. Participants also experienced little to no differences in sleep when using blue light blocking devices, such as glasses or phone widgets[2].

Two of the studies placed more emphasis on the effects of topics thought about or researched before bed than the effect of blue light[1]. Yet another study confirmed that an average amount of blue light exposure has no damaging effect on the retina in mice, and that blue light from sunlight and technology is safe when used in moderate and recommended amounts.

Two web articles, which cite a few of these studies sum up the overall accurate conclusions about blue light. An article titled "The Truth About Blue Light[5]" discusses the fallacies of the over-exaggerated articles written for the web today and concludes that blue light has not been proven to cause long-term damaging effects to a person's overall health. A second article[7] with a similar conclusion was posted by The American Academy of Ophthalmology and states that blue light exposure is completely fine when used in moderate amounts. As for its effects on sleep, it agrees with the studies stating that using blue light devices before bed impacts sleep minimally and is not worth purchasing $80 glasses for.

Conclusion

Does all of this mean anything for the average technology consumer? Is there anything to be done to improve sleep in this realm? In short, the answer is no. Science has not identified blue light as the culprit for conditions such as insomnia, restlessness, or sleep apnea. In addition, blue light has not been linked to severe damage to the body or to blindness.

The hype seen in the media today revolves around two things: cyclic marketing and wisps of scientific research. Since the original blue light study did mention that blue light could *potentially* keep people up and that overexposure to it could *potentially* cause damage, the media has everything it needs to exaggerate those very much unknown facts. By mass-producing intimidating and persuasive articles, consumers become concerned about their health and wellbeing and, once again, look to the media to provide the solution. In this case the solution proved to be $80 glasses and phone widgets, and then, because of the popularity surrounding these products, consumers continued to worry. Therefore, the cycle continues, and the issue becomes one more of marketing tactics than actual health concerns.

While a consumer may legitimately be experiencing problems sleeping, blocking the blue light will most likely not solve this issue. In reality, the blame falls more on the brain and its attention to reading, watching, streaming, and doing and less on the eyes that feed the brain these

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5.Fleming, Amy. "The Truth about Blue Light: Does It Really Cause Insomnia and Increased Risk of Cancer?" *The Guardian*, May 28, 2018.
7.Vimont, Celia. "Should You Be Worried About Blue Light?" American Academy of Ophthalmology. September 20, 2018

things. Thinking involves more alertness than seeing, and the act of making a purchase so that you can see less and think more does nothing to solve the issue at hand. Blue light blocking devices allow less light to be seen, and more screen to be read: the trap of money-making, half-truth telling business. This trap convinces its readers that they will suffer blindness, permanent eye damage, sleeplessness, and everything short of brain cell departure unless they purchase their product. Unfortunately, media disperses this trap far easier than the logic science provides.

Here is the logic: when they mind is asleep, the eyes will follow[2]. Sleep requires the mind to rest, and the eyes simply follow. Sleep requires thoughts to quiet and stress to cease, and the eyes simply follow. Sleep requires the mind to read less, so that the eyes see less. So, when trying to fall asleep individuals must not worry about what light they do or do not see because this awakens the mind. When trying to fall asleep, people should not wear protective glasses so that they can think more without the eye strain. This awakens the mind. People should not move to unfamiliar forms of light or to different activities than normal in order to avoid blue light. This awakens the mind. Instead, people should do what quiets the mind, not the eyes. After all, the eyes simply follow.

2.Jung-Yoon, "Effects of Smartphone Use with and without Blue Light at Night in Healthy Adults: A Randomized, Double-blind, Cross-over, Placebo-controlled Comparison." *Journal of Psychiatric Research (December 9, 2016): 60-70.*

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2.Jung-Yoon, Heo, Kim Kiwon, Fava Maurizio, David Mischoulon, George I. Papakostas, and Kim Min-Ji. "Effects of Smartphone Use with and without Blue Light at Night in Healthy Adults: A Randomized, Double-blind, Cross-over, Placebo-controlled Comparison." *Journal of Psychiatric Research*87 (December 9, 2016): 61-70. Accessed September 30, 2018. doi:https://doi.org/10.1016/j.jpsychires.2016.12.010.

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6.Harrison, Laird. "Is 'Blue Light' Really That Bad for Us?" Medscape. April 23, 2018. Accessed October 1, 2018. https://www.medscape.com/viewarticle/895399#vp

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8.4greatvision. "Blue Light Is Destroying Your Eyes." Dr. Facchiano and Associates, PC. Accessed September 30, 2018. https://www.4greatvision.com/blue-light-destroying-eyes/.

9.Hughes, Calvin. "Your Phone Might Be Making You Blind." Civilized. August 17, 2018. Accessed October 04, 2018. https://www.civilized.life/articles/your-phone-might-be-making-you-blind/.