Illuminating the Effects of Blue Light Emitted by Electronic Devices

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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INTRODUCTION

The phenomenon known as “blue light” has been integrated throughout modern society due to the widespread use of electronic devices such as smartphones, tablets, and computers. While blue light is an essential component of natural sunlight and has several health benefits, overexposure to artificial blue light emitted by electronic devices has been linked to several potentially negative health effects.

Unfortunately, most electronics users do not even know these risks exist. There is little information regarding potential health dangers available to the average user who is not actively looking into blue light research. In fact, many have no idea what blue light even is.

I believe that if there is research indicating the existence of adverse health effects brought on by blue light emitting devices, consumers have the right to know about it without having to scour the internet to find it. If consumers knew that there were some serious risks involved with using their phones and computers, many would not use them for upwards of 10 hours a day as they do now, causing electronic companies to pivot to a safer solution.

When looking for verification of this theory, look no further than what happened to lead-based paint, which was the foremost paint product throughout the mid-1900s. Lead paint was extremely durable and high-quality, but it was banned in the United States as of 1978 because researchers figured out lead poisoning from the paint was killing people. As such, paint companies were forced to come up with alternatives that did not pose this serious health risk. I believe something similar would happen with current electronic devices if demand required it. But first, consumers actually need to understand what they are getting themselves into when they go out and buy that new phone or laptop.

In this paper, I first dig into the aforementioned blue light research, uncovering the truth behind blue light based on studies that have been completed to this point. I reveal the empirical results of the studies and then dive into a deeper analysis of what those results imply.

After completing this research and analysis, I argue, via the STS Public Policy Framework, whether an informative campaign and legal action are appropriate to make the research more readily available. Research studies are again used, this time to reveal the dos and do nots when it comes to using informative campaigns and policy reform. After analyzing these studies, I wrap up by proposing the best plan of attack going forward to ensure electronics users are properly educated.

BACKGROUND

Blue light is a type of high-energy visible (HEV) light that has a shorter wavelength and higher energy than other visible light colors like red and green. This means that it can penetrate deep into the eye, putting the retina under increased stress. This is why our eyes cannot stare at the sun for very long and tend to feel strained when starring at bright electronic devices for long periods of time.

Blue light also plays an important role in regulating sleep-wake cycles and alertness, as it suppresses the secretion of the sleep-inducing hormone, melatonin, and stimulates the production of the wake-promoting hormone, cortisol. Thus, when the sun rises, our brains know it is time to get up, and when it goes down, we know it is time to go to sleep. Excessive exposure to artificial blue light at times where natural blue light is not available, i.e. at night, can trick our minds into still thinking it is still daytime, which disrupts circadian rhythm and can negatively impact sleep quality.

Blue light specifically is used in electronic devices like smartphones, laptops, and tablets because it has a higher efficiency in producing light compared to other colors. This allows these devices to have bright, clear displays. Additionally, blue light is thought to enhance contrast and readability on screens, making it easier for users to read text and view images and to have a stimulating effect on the brain, which can help users stay alert and focused.

Why Does This Matter?

Understanding the effects of blue light is particularly important given the increasing prevalence of electronic devices in the average person's daily life. In 2015, Lauren Hale & Stanford Guan published a survey in the Journal of Adolescent Health, finding that 90% of teenagers report using electronic devices for at least 2 hours per day, and 73% report using them in the hour before going to bed (Hale & Guan, 2015). These numbers are already staggering, and they were gathered before the COVID-19 pandemic.

More recently, in 2021, the Pew Research Center determined that 97% of Americans own a cellphone of some kind, with 85% owning smartphones, roughly 75% own a desktop or laptop, and roughly 50% own a tablet computer (Pew Research Center, 2021). The pandemic has led to a significant increase in the use of electronic devices for remote work and online learning. Both seem to be here to stay, and they have brought with them many more activities that rely on electronics. As a result, individuals are spending more time in front of screens than ever before, and their exposure to blue light is consequently increasing at an alarming rate.

CURRENT STATE OF BLUE LIGHT RESEARCH

Blue Light and Eye Health

One of the most cited risks associated with blue light exposure is damage to the eyes, particularly when it comes to the development of age-related macular degeneration (AMD), a leading cause of vision loss in older adults. The macula is a small area in the center of the retina that is responsible for our central vision, and it is particularly vulnerable to damage from blue light exposure.

Jiyoung Moon and collaborators studied the effects of blue light on the retinal pigment epithelium (RPE), a layer of cells in the retina that is critical for maintaining the health of the eye's photoreceptor cells. The study found that exposure to blue light led to an increase in oxidative stress and damage to the RPE cells. Oxidative stress is a key factor in the development of AMD (Moon et al., 2017).

Additionally, Fiona Cuthbertson and colleagues, with the Journal of Cataract and Refractive Surgery, investigated the effects of blue light-filtering intraocular lenses on the progression of AMD among other ocular disorders. Their review found that there is ample data indicating that wearing blue light-blocking glasses significantly slows the progression of AMD. Their findings suggest that blue light-blocking measures could be an effective strategy for preventing the progression of AMD and preserving visual function (Cuthbertson et al., 2009).

While the long-term AMD-related effects of blue light exposure are still being studied, there is growing evidence that blue light may contribute to short-term "digital eye strain". The American Optometric Association defines digital eye strain as "the physical discomfort felt after two or more hours in front of a digital screen and is associated with the close to intermediate working distances of digital screens".

To illustrate this phenomenon, Urmil Chawla and coauthors conducted research on undergraduate medical students indicating that those who spent extended time looking at digital screens developed symptoms such as eye fatigue, dryness, and discomfort, as well as headaches and trouble concentrating (Chawla et al., 2021).

Blue Light and Sleep

Another significant concern regarding blue light exposure is its effect on sleep through the suppression of melatonin, which regulates the body's sleep-wake cycle. Our bodies naturally produce more melatonin in the evening when it is dark, which helps us fall asleep and stay asleep through the night. However, exposure to blue light before bedtime can disrupt this natural process, making it harder to fall asleep and reducing the quality of our sleep.

Anne-Marie Chang and colleagues, members of the Harvard Medical School, found that exposure to blue light in the evening hours can disrupt sleep and lead to negative effects on mood and cognitive performance. The study also found that using devices with lower levels of blue light, such as e-readers with a night-mode setting, can reduce the negative effects of blue light exposure on sleep (Chang et al., 2014).

Kenji Obayashi and collaborators, writing in the journal "Chronobiology International", determined that exposure to blue light at night was associated with poorer sleep quality and daytime dysfunction, as well as increased risk of depression and anxiety (Obayashi et al., 2018).

However, certain other studies have suggested that the impact of blue light on sleep may not be as significant as previously thought. In 2019, Mariana Figueiro and coauthors, with the University of Manchester, found that blue light exposure from electronic devices had no

significant effect on sleep quality or duration (Figueiro et al., 2019). The researchers noted that the study was conducted under controlled conditions, and further research is needed to fully understand the impact of blue light exposure on sleep in real-world settings.

Blue Light and Skin Health

In addition to its potential impact on eye health and sleep, blue light exposure has also been linked to negative effects pertaining to skin health. Due to its short wavelength, similar to that of ultraviolet (UV) light, blue light can penetrate deeper into the skin than other wavelengths of light, leading to oxidative stress and damage to skin cells.

Frank Liebel and colleagues, with the University of California, Irvine, conducted a study finding that exposure to blue light caused more damage to skin cells than exposure to UV light (UV light is what we are trying to protect ourselves from when we wear sunscreen) (Liebel et al., 2012). The researchers noted that the damage caused by blue light exposure could contribute to premature aging and skin damage.

Siddarth Mukherjee and collaborators, with the University of Exeter, noticed that blue light exposure can lead to the development of dark spots on the skin, known as hyperpigmentation (Mukherjee et al., 2019). The study found that exposure to blue light caused a significant increase in melanin production in the skin, which can contribute to the development of hyperpigmentation.

Although the links are there, most studies conclude that further research is needed to fully understand the relationship between blue light and skin health and that artificial blue light from electronic devices (as opposed to blue light from the sun) is not a concern for skin health.

Blue Light and Cognitive Performance

While much of the research I've discussed focuses on negative health effects associated with blue light, some studies have suggested that blue light exposure may also have positive effects, particularly on cognitive performance.

Lorenzo Tonetti and Vincenzo Natale conducted a study that concluded as such. They determined that short-term exposure to blue light led to improvements in several cognitive aspects, including faster reaction times and improved memory recall (Tonetti et al., 2018).

However, Mohamed Boubekri, Ph.D., and coauthors published a study in the journal "Scientific Reports" that determined exposure to blue light in the morning improved mood and cognitive performance in healthy adults, while exposure in the evening had the opposite effect (Boubekri et al., 2018). While more research is needed to fully understand the relationship between blue light and mood, these findings suggest that the timing of blue light exposure may be an important factor to consider.

Blue Light and Children

Finally, it is worth noting that children may be particularly vulnerable to the negative effects of blue light exposure, given their developing eyes and increased use of electronic devices. Several studies suggest that blue light exposure may contribute to the development of myopia, or nearsightedness, in children as well as cause changes in eye shape and thickness of the retina. However, more research is needed to fully understand to what degree these dangers are heightened for children compared to fully developed adults.

WHAT TO DO WITH THIS INFORMATION

Overall, research on the effects of blue light exposure is complex and multifaceted. Although some research is not entirely conclusive at this point, it is clear that there is enough research out there to raise some causes for concern regarding blue light exposure. These concerns do not appear severe enough to demand an alternative solution to blue light usage in electronic devices entirely, but they certainly show the need for some form of informative action. There are simply too many studies out there concluding that blue light *does* have negative health effects to ignore. The consumer deserves to know what they are getting themselves into, particularly as electronic device usage year over year continues to increase at a significant rate. Without informative action, we will soon hit a threshold where electronic devices are so ingrained in our society that it is too late to make any adjustments.

Unfortunately, electronic device providers, such as Apple and Microsoft, will be unwilling to reveal information that could potentially reduce user interaction with their devices, unless they are forced to. Thus, I recommend a two-pronged strategy to get blue light exposure information to the consumer: launching a third-party informative campaign with in-person/online Q&A sessions and television advertisements as well as enacting policy change to force companies to reveal the risks more clearly on their packaging and in their advertisements.

Informative Campaign

To recommend an informative campaign with the best chance of success, I looked through a series of studies to determine the most important aspects of structuring said informative campaign. This is what I found:

One key factor that can make or break an informative campaign is its message framing. Campaigns that use positive framing tend to be more effective at promoting behavior change than those that use negative framing. Positive framing emphasizes the benefits of adopting a particular behavior, while negative framing emphasizes the costs or risks of not adopting it. For example, a campaign to promote recycling might use positive framing by emphasizing the environmental benefits of recycling, rather than negative framing by emphasizing the negative impact of not recycling. Positive framing tends to be more motivating and persuasive, as it taps into people's desire for positive outcomes and avoids triggering defensiveness or reactance.

Targeting the right audience is another important practice for designing informative campaigns. Different messages may resonate more strongly with different segments of the population, depending on their demographics, values, and beliefs. Therefore, it is important to conduct audience research to understand the needs, interests, and attitudes of the target audience, and tailor the message accordingly. For example, a campaign to promote healthy eating habits might target parents with young children and emphasize the benefits of setting a good example for their kids.

In addition, effective campaigns often use multiple channels to reach their target audience. Traditional media such as television and print ads can be effective, but digital and social media platforms are increasingly popular and offer a wider reach. However, it is important to use the right channels for the target audience, as different age groups and demographics may have different media consumption habits. For example, a campaign targeting older adults may use traditional media such as newspapers and TV ads, while a campaign targeting younger adults may use social media platforms such as Instagram or TikTok.

Finally, campaigns should be designed with measurable outcomes in mind and evaluated to assess their effectiveness. Measurable outcomes could include changes in behavior, knowledge, attitudes, or perceptions, and can be assessed using surveys, focus groups, or other evaluation methods. By measuring the outcomes of the campaign, it is possible to determine which elements were most effective and make improvements for future campaigns.

With all of these recommendations taken into account, the best campaign for this issue is one that emphasizes the positive effects of regulating ones electronic device usage (being able to go outside, spend more time with family, etc.).

The campaign should be focused on using social media platforms to target teenagers/young adults who are using electronic devices more than any demographic and have the most time to change their habits before long term negative effects arise. Using television as a channel for advertising is also ideal because television spans a wide range of demographics. Since this issue is not overly particular to one demographic over another, a wide-reaching channel like television would be best to reach the most people. Using print media is not overly necessary because those that use print media as their primary source of information are not using electronics much in the first place (this typically pertains to the older population).

Lastly, it would be a smart idea to host a series of Q&A sessions and surveys to get a sense of whether the campaign is having any effect or not. These evaluation methods should ask people's opinion of the campaign as well as evaluate whether they understand the information presented/have done anything to reduce their blue light exposure.

Policy Change

Similar to the research conducted for structing a successful informative campaign, I took a look at a series of studies pertaining to policy changes that force companies to reveal potential negative effects of their products for the greater good of society. Some changes yielded positive results, and some did not.

One example of successful policy change is the regulation of cigarette advertising in the United States. In the mid-20th century, there was growing concern about the negative health effects of smoking, and in 1965, the Federal Cigarette Labeling and Advertising Act was passed, requiring all cigarette packages sold in the US to carry a warning label about the health risks of smoking. This policy change was successful in raising awareness of the dangers of smoking and reducing cigarette consumption.

The regulation of food labeling is another example of successful policy change in the United States. In 1990, the Nutrition Labeling and Education Act was passed, requiring all packaged foods to carry a standardized nutrition label, including information about the amount of fat, calories, and other nutrients in the product. This policy change has helped consumers make more informed choices about the food they eat and has contributed to a healthier population overall.

However, not all policy changes have been successful in improving consumer wellbeing. The foremost negative example is the pharmaceutical industry's practice of including lengthy warnings and disclaimers in their advertisements. While these warnings are meant to inform consumers about potential side effects of drugs, research has shown that this can scare consumers away, making consumers less likely to seek treatment for their conditions.

Fortunately, policy changes related to warning consumers about the dangers of overusing their electronics should not have any of the negative consequences like those seen in the medical industry. It is highly unlikely that requiring warnings about blue light will encourage users to abuse electronics further, which would be the negative outcome here.

The result in our case would likely be more like the first two examples, where, once companies were required to provide more information to their consumers, consumers made more informed decisions that benefited their health. The policy changes did not eliminate smoking entirely or stop people from eating unhealthy foods, but by simply providing the information such that consumers could make a more educated choice regarding their smoking or eating habits, the general trend showed there was a positive impact on the health of the average consumer. Thus, legal action does seem to make sense, requiring electronics companies to more clearly reveal the risks associated with overusing their products.

FINAL DISCUSSION

Overall, research shows that artificial blue light emitted from electronics can pose serious health issues for users. However, the general population is largely unaware of this fact, and, at the current rate, is going to continue using electronics upwards of 10 hours each day without thinking twice. Since this level of activity can lead to health issues down the line, users should be able to weigh all the pros and cons of using electronics for this amount of time and decide for themselves. However, to do that, they need access to all the information.

Thus, I recommend launching an informative campaign discussing the effects of blue light exposure from electronics as well as implementing national policy changes forcing companies to be more forthright with their consumers. My recommended changes would put the

ball back in the user's court and, if executed correctly, should result in safer practices for the overall population.

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