How has technology impacted sleep?

Rishi Sethia - 981190

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How technology impacts sleep

Light-emitting diodes (LEDs) have become the go to choice for illuminating modern devices. These range from mobile devices to laptop screens and more. LEDs are cheap and small, making them useful for small devices [1].

Modern LEDs emit a white light made up of blue light and yellow phosphor [2]. It is this blue light that negatively interacts with sleep.

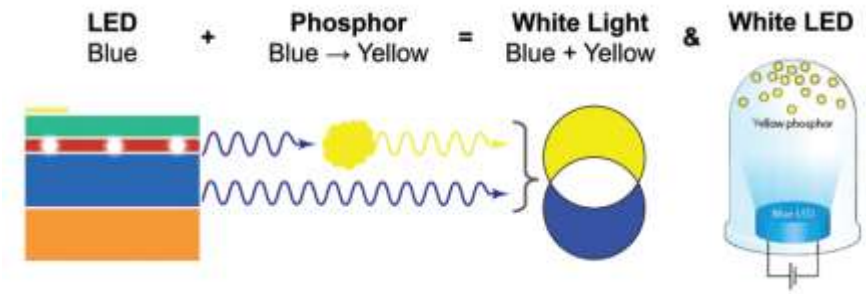

Figure 1 - Diagram showing how white light is made from blue and yellow light [2].

The graph on the right shows the power output of three different sources. Blue light has a wavelength of around 450 and 470 nm (outlined in red), and the graph clearly shows that the blue light emitted is very intense. Studies have shown that blue like can shift our circadian clock [1].

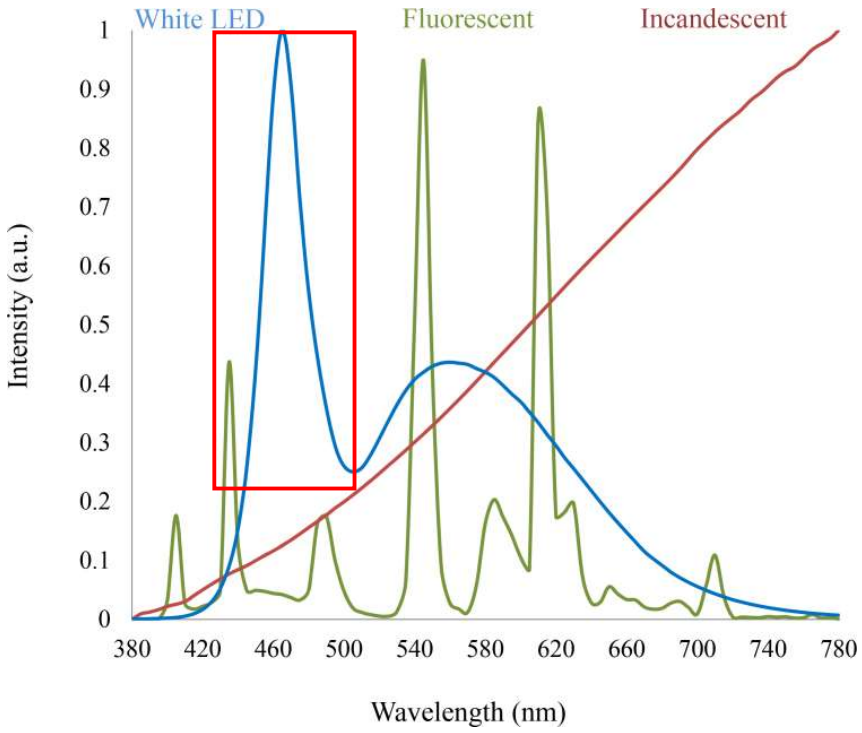

Figure 2 - Graph showing the power spectrum from three different light sources [1].

The sleep facilitation hormone melatonin is secreted at night and in darkness. Any exposure to light can delay or completely stop secretion. A wavelength of around 460nm is remarkably effective at disrupting the hormone [3]. As a result, the person's biological clock is shifted, meaning they sleep later and wake up later [4].

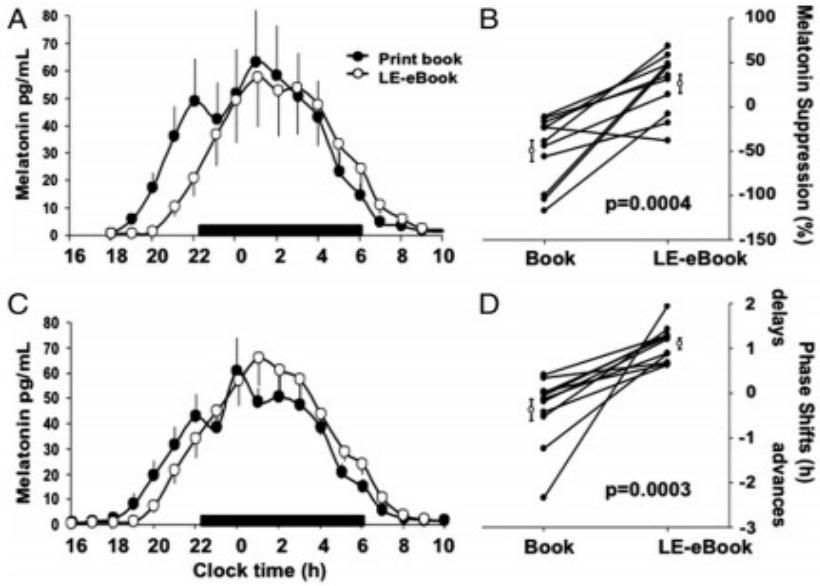

Figure 3 - Graphs A and B represent melatonin suppression, C and D represent phase shifting of the biological clock. The black bar shows the designated sleep episode [4].

The graph shows the different melatonin levels and the phase shifting that occurs between individuals who read a print book and those who read a light emitting eBook. Subjects who used the LE-eBook had more melatonin suppressed and had more phase shifts than those who read a print book. Participants who used the LE-eBook were reported to be sleepier in the morning, and it took them longer to wake up properly [4].

Sleep deprivation can severely impact a person's health, with it increasing the risk of obesity, stroke, and depression. The US has seen an increase of overweight and obese citizens; in 2004, one third of the adult population was obese, and 17% of children and teenagers were overweight. Some of this is due to diet changes and an increase in sedentary activities (e.g., watching TV or using a mobile phone). This has reduced the amount of sleep people get and is fuelling this health issue [5].

Due to phase shifting the biological clock, children who are sleep deprived become hyperactive and lack concentration. This could lead to mistaken diagnoses of attention-deficit hyperactivity disorder (ADHD) [6]. Giving a child medication that they otherwise would not need can be detrimental to them.

There has been a link to musculoskeletal issues as well. Long sitting hours using a computer or phone in a static, stationary position can lead to pain in the lower back and neck-shoulder region. Interactive media like the Internet can be addictive for some, leading to even more time spent developing musculoskeletal problems. Some studies have found a direct link between adolescent girls' mobile phone usage and poor perceived health, including musculoskeletal and psychological problems. This is a big problem, especially during the years where the body is rapidly changing, and hormone production increases [7].

A lack of sleep can lead to an increased risk of depression, especially in adolescents. Adolescents, more so college students, must multitask their college life, which adds stress, compounded with late nights using several forms of technology, leading to a greater risk of depression. This leads to them having difficulties falling asleep, which leads to a more significant phase shift. As discussed earlier, this throws the circadian clock entirely out of order [8, 9].

Why has there been an increase in sleep deprivation?

From the 2000s onwards, there have been significant strides to make technology such as phones, computers, and TVs more accessible to the broader market. These devices have become more powerful while also decreasing in size. This leads to a more portable form factor meaning that people can interact with devices that alter their sleep more frequently and easily. Modern devices have become more affordable, meaning more people can access the technology, which further suggests that more people will be potentially subjected to sleep deprivation [10]. An example of the increase in power can be seen in mobile phones. Phones can now do more than call. They can be used to browse the Internet, message, social network, play music, and play games, to name a few. The ease and increased accessibility of wireless connections in homes have allowed people to use their phones anywhere in the house [11].

The graph on the right shows the price trend in premium and budget mobile phones. The budget mobile trend will appeal to a broader demographic of people because it's more affordable. However, that does not mean people are not buying premium phones. Recently they are more of a status symbol due to changes in society [12].

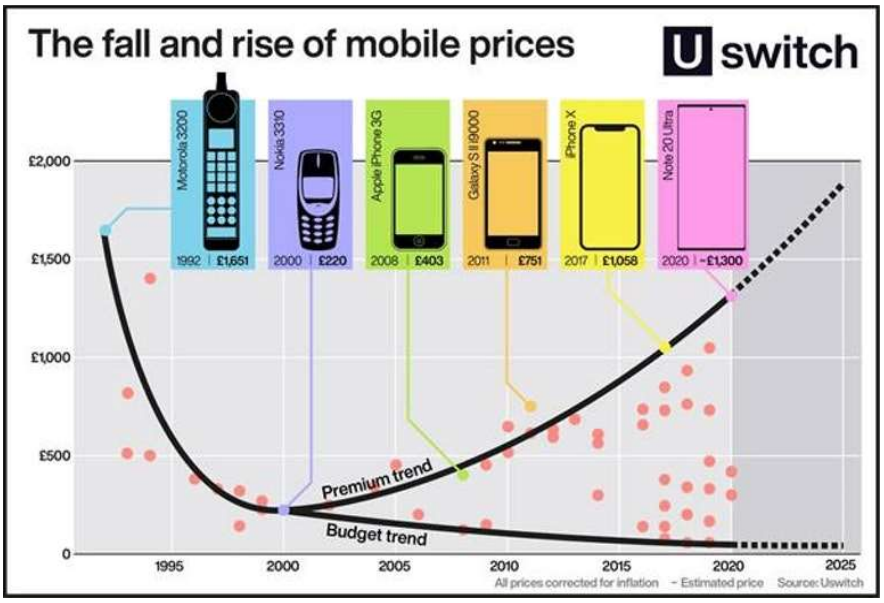

Figure 4 - Graph showing the price trend of mobile phones over time [12].

What is being done to reduce technology related sleep deprivation?

Not much has been done to combat technology related sleep deprivation. Many modern devices have a yellow filter or night light mode. There have been varying degrees of information regarding if night mode is effective at suppressing melatonin production or not.

Some research shows that the “Night Shift” mode in Apple iPad suppresses far less melatonin than blue light, nearly a 40% difference between Blue Light Goggles at 2 hours and Night Shift Low Colour Correlated Temperature (CCT) (see figure 5)[13].

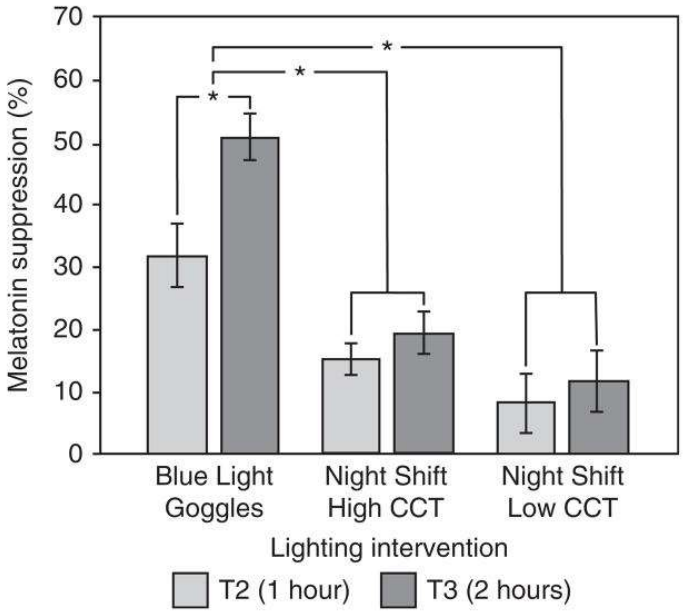

Figure 5 - Melatonin suppression by varying forms of light [13].

However, on the other side, some research has found that there is not much difference between normal white light and Night Shift regarding melatonin suppression. From 2 hours of exposure to an iPad in “regular” settings, about 23% of melatonin was suppressed, 19% using Night Shift High CCT, and 12% on Night Shift Low CCT [14].

In the first experiment, subjects had to wear blue light goggles that exposed them *“to a high circadian stimulus”* [13]. This means that they were exposed to more blue light than the subjects in the second experiment, which means it is not fair to compare these. This goes to show that more research needs to be done in this aspect.

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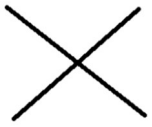
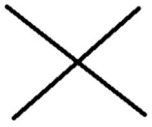
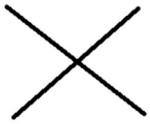
Mark Scheme (out of 28+2 marks total)

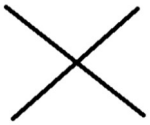
*Note: to reach each mark boundary, all the requirements for previous mark boundaries must also be met or avoided where a negative trait is described. For example, to receive 3 marks for spelling, you must meet all the criteria for 3 marks and **not** have spelling errors that a spell checker would find (a criteria associated with 1 mark)*

Spelling and grammar (3 marks)		
Grade boundary	**Description**	**Self-assessment**
3	The report reads well throughout with none of the issues identified below appearing. The writing would not look out of place in an academic publication	
2	The report can be understood on first read through. However, some sentence construction is awkward and/or there are comma splices, imprecise language, copy splices or awkward phrases	
1	The report does not contain spelling or grammatical mistakes that a spellchecker would find	

IF YOU HAVE A REGISTERED DISABILITY THAT AFFECTS YOUR ABILITY TO BE ASESSED FOR SPELLING AND GRAMMEAR (FOR EXAMPLE, DYSLEXIA) PLEASE INDICATE IN THE ABOVE SECTION

Use of Sources (8 marks)		
Grade boundary	**Description**	**Self-assessment**
7-8	The report backs up all claims that it makes with appropriate references. The references include at least 8 appropriate academic papers that are used meaningfully in the report. The report uses a total of at least 14 sources.	
5-6	The report backs up the majority of claims that it makes to the satisfaction of the marker. The references include at least 6 appropriate academic papers that are used meaningfully in the report. The report uses a total of at least 12 sources.	
3-4	The references include at least 4 appropriate academic papers that are used meaningfully in the report. The report uses a total of at least 10 sources.	
1-2	The references include at least 2 appropriate academic papers that are used meaningfully in the report. The report uses a total of at least 8 sources.	

Information Presentation and Structure (7 marks)		
Grade boundary	**Description**	**Self-assessment**
6-7	The report consistently uses formatting appropriately. The document includes some graphical information produced by the student to help emphasise their point. Information is consistently presented in graphical form where appropriate. The document is very easy to follow and looking at the contents page of the document gives a good level of insight into the report	
4-5	The report generally makes use of formatting to clarify its information (bolded text, subtitles, italicised text, bulleted or numbered lists where appropriate) and presents information in forms besides text such as graphs, tables or images. The document escapes the "Intro->Method->Results->Conclusion Trap" we discuss in class on the topic of report writing	
2-3	The report intermittently makes use of formatting, but it doesn't consistently help get a point across. As a reader, I could read the sections in any order and it would make little difference OR the document is relatively unstructured with few sub-sections or unhelpful section titles	
1	The report makes no use of anything other than written text to present its information, formatting is inconsistent. There are appropriate subheadings, but they are poorly related to each other. The document is unstructured, there is no use of sections to segment the information and help the reader	

Quality of Analysis (10 marks)		
Grade boundary	**Description**	**Self-assessment**
9-10	The document includes more than one non-obvious insights into the topic being discussed that is clearly the students own work. The student consistently makes the distinction between fact and opinion clear	
7-8	The document explains the domain being presented clearly and in depth. The document includes a good amount of discussion and analysis. At least one non-obvious insight is presented that the marker is satisfied is the students own work. The student clearly critiques and compares their sources whenever it is appropriate	
5-6	The document explains the domain being presented. The document includes a good amount of discussion and analysis. Some non-obvious insights are presented by the student, but these don't have a clear chain of logic to them and may simply be the insights of other work being rephrased by the student. The student rarely confuses opinion and fact in their discussion. The student only infrequently engages critically with their source	
1-4	The document includes a limited amount of discussion and analysis. The document generally lacks insights into the problem area only repeating others' information or does not make the topic area clear. The student only engages critically with their source on an infrequent basis	