In today's world, technological devices are found everywhere. Society is immersed in the use of different types of devices for daily tasks. This exposure to technology has an impact on the brain. Light and radiofrequency radiation produced by devices, such as cell phones and television, are contributing factors to conditions including brain cancer, ADHD, or Attention Deficit Hyperactivity Disorder, and epilepsy. Research revealed adolescents exposed to cell phones have an increased risk of developing brain cancer. Furthermore, those who play video games are likely to develop ADHD symptoms and epileptics are likely to suffer from seizures. The use of technology can affect the brain in various ways, including the risk of brain cancer, ADHD symptom development, and stimuli for those who suffer from epilepsy.

With research conducted on the correlation between the possibility of brain cancer and cell phones, information about the effect of technology on the brain has been revealed. Richter and Weinberger (2002), cardiologists who conducted research at NYU, found that the brain acts as an antenna for the body which intercepts radiofrequency radiation (RFR). RFR can have harmful effects on the brain. Because the brain is the receptor of the RFR, an increased risk of brain cancer occurs. People in today's society seem to always have their phone with them, exposing them to the radiofrequency waves being produced. Al Taweel (2016) of the Department of Neurology at Zagazig University in Egypt discovered those who have been exposed to cell phones for more than 10 years have a higher risk of developing brain cancer in their lifetime. Adolescents and young adults who use cell phones have been exposed to RFR given off by cell phones for most of their lifetime. The development of the brain could be affected by too much exposure to RFR.

Despite past research, there are still no conclusive results to the idea that cell phones

contribute to the development of brain cancer. Researchers Kohli and Sachdev (2009) of the Department of Internal Medicine in India, and Vats (2009), a researcher at the University of Wisconsin, Madison at the Government Medical and College Hospital, found studies conducted on the correlation of brain cancer and cell phones, have unclear results. Results have indicated there is both a positive and negative correlation between cell phones and brain cancer. A research team at the International Agency for Research on Cancer "updated their previous study covering up to the year 2008 and concluded the same" results as their previous research that was unable to prove a correlation between cell phones and brain cancer (Deltour et al., 2012, p. 54). Researchers are unable to conclude cell phones are a factor in the cause of brain cancer and more research is needed. The only conclusion that can be made currently is that there is an increased chance of brain cancer for those who have been exposed to cell phones for many years. No research thus far is able to conclude definitively that cell phones are a contributing factor to brain cancer.

In addition to the possible risk of developing brain cancer, symptoms can occur from overuse of devices and the exposure to RFR. Because of the exposure to light and radiofrequency radiation emitted from the cell phone, television, or computer screen, the brain can be affected and begin to show symptoms of ADHD, or Attention Deficit Hyperactivity Disorder. Allan (2011), an assistant professor of counseling psychology at Purdue University, and his team of researchers found the use of mobile phones can be associated with ADHD symptoms which can also support the idea that RFR affect the development of children's brains. With exposure to cell phones at an early age, the RFR emitted can affect the development of the brain. Children who play games on phones at a young age are likely to develop ADHD-like behaviour. Other research

of Allan and his team (2011), however, revealed more time spent playing games on a mobile phone could be a cause of ADHD-like behaviour, not an effect of RFR exposure to the brain. This research reveals the RFR exposure is not the main cause of the symptoms associated with cell phones. Instead, the time spent playing the games could be the bigger problem. The more time a child spends on a cell phone could lead to more ADHD symptoms from the addiction to the game and lack of social interaction.

Due to the light and visuals presented, epileptics are likely to experience a seizure while watching television. Fylan (1999), a health psychologist, and other various researchers of seizures state television and video games act as some of the most common daily triggers in the technological environment of the present world. Video games are a stimulating activity for the brain, but for some people they can be overstimulating. With all the action and visuals occurring, individuals with photosensitive epilepsy, a type of epilepsy triggered by lighting and patterns in the visual environment, can become overstimulated and have seizures. Most video games are full of action which can be dangerous for sufferers of photosensitivity. Research conducted by Takahashi (2002), from the Division of Neuropsychiatry at the Sendai City Hospital, revealed photosensitivity is the main cause of seizures occurring during video game activity. The visuals on the screen and the light cause the brain to be stimulated and a seizure to occur. Other stimuli, however, can cause a seizure which occurs while playing video games.

In addition to the light potentially causing a seizure, colors and patterns can cause photosensitive epileptics to suffer from a seizure while playing video games or watching television. Kasteleijn, educated in neurology and public health at Trenité of Utrecht University, and her team of researchers (2002) found sufferers of photosensitivity can be affected by the

patterns and color combinations present in video games. Although photosensitive means one is sensitive to light, with epilepsy, photosensitivity can also be associated with certain colors and patterns. In video games, patterns and colors are often present. A mixture of the patterns, and colors can cause photosensitive epileptics to have a seizure. Kasteleijn and her team (2002) also discovered different types of technology emit light in different ways, so each will have its own effect on photosensitive people. In the world today, technology advanced greatly. Whether it be a computer screen, television, cell phone, or tablet, each type of electronic emits light differently. Photosensitive individuals may find it hard to know what electronics trigger their seizures due to the different types of light. Some people may react to one electronic's light emission but not another.

The health of the brain can ultimately be affected by the use of technology in modern day times. Research reveals RFR, or radiofrequency radiation, affects the development of the brain in adolescents and children. It also has the possibility of causing brain cancer. The light emission from the device screens act as stimuli for epileptics and factor into ADHD symptoms. Epileptics who suffer from photosensitivity can be affected by the patterns and colors seen on screens as well. As the technological market advances, the exposure to screens will increase. With an increase of exposure, the brain will only be affected more by technology and increase the potentiality of developing a brain disease.

Word count (without in-text citations): 1184

Annotated Bibliography

Al Taweel, Y. A., Kamel, A. E., Amr El Ghany, A. M., Nageeb, R. S., Bolbol, S. A., & Elsayed, M. R. (2016). Prevalence of risk factors including cell phone use among patients with brain tumors. *Egyptian Journal Of Neurology, Psychiatry & Neurosurgery*, 53(2), 111-118. doi:10.4103/1110-1083.183447

The authors of this article conducted research themselves. They studied patients with brain cancer and tested different things that could have an affect on the development of brain cancer. They found that exposure to cell phones for over 10 years lead to an increased risk of brain cancer.

Bureau, M., Hirsch, E., & Vigevano, F. (2004). Epilepsy and videogames [sic]. *Epilepsia* (Series 4), 4524-26. *Ebsco*host

Photosensitive epileptic patients, those that have a reaction to light, can be affected by videogames. Not all epileptic sufferers, however, are photosensitive and therefore not affected by the stimuli in videogames. The light produced by the screen and the patterns seen contribute to the possible cause of a seizure.

Byun, Y., Ha, M., Kwon, H., Hong, Y., Leem, J., Sakong, J., & Kim, N. (2013). Mobile phone use, blood lead levels, and attention deficit hyperactivity symptoms in children: A longitudinal study. *Plos ONE*, 8(3), 1-10. doi:10.1371/journal.pone.0059742

Radiofrequency electromagnetic field exposure to children from mobile phone use have harmful effects on the development of children's brain. This study examined the relationship between symptoms of ADHD, RFR exposure, and mobile phone use.

Kasteleijn-Nolst, T. G., van der Beld, G., Heynderickx, I., & Groen, P. (2004). Visual stimuli in daily life. *Epilepsia* (Series 4), 452-6. *Ebsco*host

This study examined how the light produced from television affects subjects with epilepsy. It also looked at how the color combinations and patterns in video games cause photosensitive epileptic sufferers to have seizures while playing video games.

Kohli, D. R., Sachdev, A., & Vats, H. S. (2009). Cell phones and tumor: Still in no man's land. *Indian Journal Of Cancer*, 46(1), 5-12. doi:10.4103/0019-509X.48589

This article discusses radiofrequency radiation (RFR) and its possible effects to the brain. It also includes discussion about magnetic fields. Unsuccessful research studies are presented as counterarguments to the idea that cell phones contribute to brain cancer development. The conclusion presents that there is no positive correlation between brain cancer and cell phones.

Ranjbaran, M., Khodadost, M., Mansori, K., Seyed Houssien Mousavi, J., Ayubi, E., Nazarzadeh, M., & Mosavi-Jarrahi, A. (2014). Mobile phone use and brain tumor: An age-period-cohort analysis of brain tumor rates in the Nordic population. *Basic & Clinical Cancer Research*, 6(2), 42-55. *Ebsco*host

There is discussion of if there is a correlation between cell phones and brain cancer. A conclusion was made that there is a possible positive correlation, but not a huge one. There is a large amount of statistics included within the article.

Verrotti, A., Trotta, D., Salladini, C., Corcia, G. d., & Chiarelli, F. (2004). Photosensitivity and epilepsy. *Journal Of Child Neurology*, 19(8), 571-578. *Ebsco*host

This article explains photosensitivity in epileptic patients. It goes over various stimuli that sufferers of photosensitivity have and the stimuli's effects on the body. There is a description of what type of treatment photosensitive epileptics may need when a seizure occurs.

Vijayalaxmi, & Prihoda, T. J. (2014). Mobile phones, non-ionizing radiofrequency fields and brain cancer: Is there an adaptive response? *Dose-Response*, 12(3), 509-514. doi:10.2203/dose-response.14-012.Vijayalaxmi

This article discusses the idea that mobile phone use has become a larger health concern. The more technology is used, the more somatic cells get damaged leading to an increased risk of cancer. There is no indication that mobile phones affect the progression it brain cancer or even the cause of it.