

The Effects of Digital Media Use on Youth Brain Development – A Systematic Review

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Abstract

Background: Excessive technology use in youth has been related to poor brain development. This literature study looks at the connection between digital media use and brain development in children and teenagers. **Methods:** Medical journals were analyzed in order to gather data for a systematic review. PUBMED and JSTOR were utilized to perform the searches. The abstracts and titles of the papers were inspected first, followed by the remainder of the paper. Full texts were examined and processed, and information was retrieved for use in the study. **Results:** Overall, the published data showed a strong link between digital media use in youth and poor white-matter tract integrity, especially in the Broca (speech production) and Wernicke (language development) areas of the brain (Korte, 2020). The white matter tract integrity of the brain is a universal trait, and the difference in integrity can help explain the mind's processing speed. Contrastingly, technology cannot be labeled as only having negative effects. With moderate use and consideration, digital media can be a way to expand one's knowledge. There are many opportunities to learn and grow with technology if the correct mindset is established. For now, there is not one set answer on the effects of digital media use. Extensive use will negatively impact youth health and brain development, nevertheless, benefits arise with moderate use. When more studies will become available, providing measurable accurate data on digital media utilization, progress can be made in

ascertaining how to reap the benefits of the digital informative technology.

Keywords: Technology, Brain Development, Digital Media

Introduction

Technology makes up a major piece of society and it is becoming ever more prevalent. The word "technology" used in this systematic review refers to "information technology" defined as the use of hardware, software, services, and supporting infrastructure to manage and deliver information using voice, data, and video (Michie, 2020). The true degree of the impact that technology has on people and our brain development is perplex (Anonymous, 2018). Technology has taken a strong hold on our lives, especially in the younger generation. Children are likely to invest more time on the internet and less time interacting with other people, face to face. However, functional imaging scans show that internet naive adults who figure out how to utilize the web, show significant increases in brain neural activity during online searches (Small et al., 2020). Certain computer projects and video games might improve memory, multitasking abilities, fluid intelligence, and other cognitive capacities (Anderson and Subrahmanyam 2017). There is not one conclusive standpoint that explains of the technology's effect on brain development. In moderation, the utilization of technology can be useful and allow for more parts of the brain to be used (Giedd, 2020). The risk for reward concept relates to social media platforms that directly

affect the brain reward centre and indirectly lead to addiction, anxiety and depression (Anonymous, 2021). On one hand, social media as a mean of technology use adds up to the amount of time adolescents spend online. On the other hand, it influences well-being and opinion formation. (Crone et al., 2018). Socializing on media engines could cause the brain to change and grow. Time spent learning or experiencing something is encoded in the brain by subtle changes in the strength of connections between neurons. (East, 2016). Similarly, to an appropriate work - life balance, technology use to social interactions equitable ratio is as important. The objective of this literature study was to analyze available literature, dealing with the potential effects of technology on youth brain development, with emphasis on the purpose and time scale of digital media use as indicators of impact on brain betterment.

Methods

A systematic review of research papers was conducted in order to gather data from multiple viewpoints. All studied papers were written in English and searches were done through PUBMED and JSTOR. Papers were generally screened at first, with the titles being reviewed, followed by further analysis. To allow for replicability, key words were used to conduct these scans. This formed a collection of possible papers to analyze. The terms included in the search were: “brain”, “technology”, “development”, “digital media” and “neuro”. By narrowing it down to these terms, irrelevant papers were less likely to appear, and search results had a greater chance of aligning with the selected systematic review topic. In total, 109 papers were produced by the original title scan. Once reviewed, papers with relevant titles were used for abstract analysis. From there, abstracts of 14 papers were looked at. Many of the papers in the original selection were removed from further analysis due to irrelevance. Some articles mentioned ideas about digital media use but did not relate it to the brain in any way, while other

papers would discuss brain development of those with diseases.

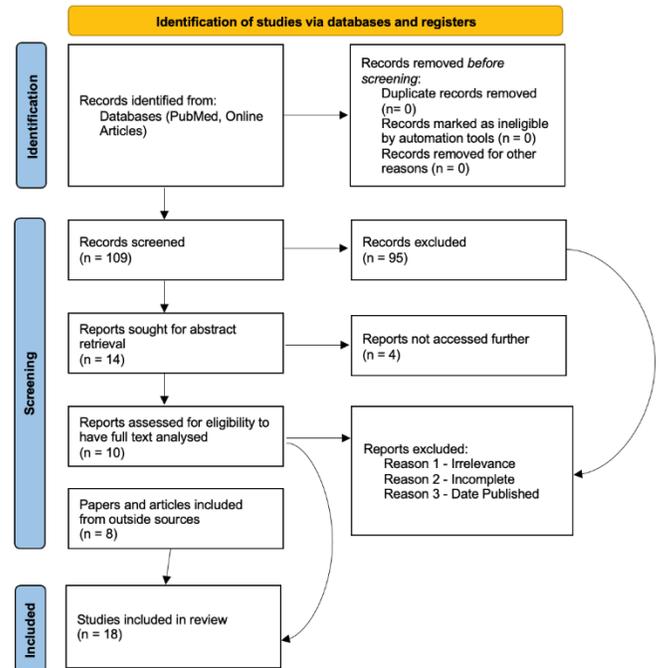


Figure 1: Schematic illustration of the evaluation procedure used for the systematic literature review

Furthermore, there were several articles which appeared to be relevant but could not be accessed with the available means (i.e., paid subscriptions, incomplete documents). The final criteria for exclusion involved assessing the date of publication. Only articles which were published from 2015 to present were considered to have reliable data. Essentially, in order to align with the proper requirements, abstracts needed to be published recently in terms of scientific research, and mention ideas about the effect of digital media on the brain. If the abstract was on this general topic, full texts were analyzed, and data then extracted to be used in the research. Of the 14 abstracts which were read, 10 papers were then examined and analyzed in detail. Several abstracts which were read were not included as the paper addressed a different topic than the one of current interest; not enough data could be obtained for relevant research purposes. With the

remaining papers, the data obtained were interpreted and used in a review. In addition, there were 8 other papers and articles included, which were obtained from outside sources. These reports had relevant information which could be directly applied in the study. A total of 18 papers were used to gather data for this systematic literature review.

A PRISMA 2009 diagram was applied as an evaluation procedure to guide and route the source information (Moher et al., 2009) – Figure 1.

Results

People who are constantly using technology have less opportunity to communicate offline and rest their brain in its default mode (Small et al., 2020). Neurological ramifications have been associated with internet addictions. There is a significant connection between early childhood digital media use and poor white-matter tract integrity, particularly between the Broca and Wernicke brain regions. Although it is not certain if social media or the act of looking at screens is the cause of poor sleep, it has been proved that exposure to certain wavelengths of light dictates the circadian rhythm that influences sleep. Most light emitting diodes (LEDs) from computers and phones give off a slow wave of blue light that negatively impacts the circadian rhythm (Small et al., 2020). The utilization of technology impacts the brain, forming different connections and changing human cognition. An environment that encourages short attention span, without interpersonal communication, and that is addictive or compulsive will shape a person's life. Digital media can leave an unprecedented mark on the brain, especially since some teens are racking up to nine hours of digital media use a day (Briggs, 2017). In limited application this use might not have negative effects, but studies show that time spent online is increasing. In 2005, adolescents spent about eight hours per week online, while in 2017 the average had more than doubled to 18.9 hours a week (Przybylski and Weinstein, 2017). The degree to which this

extensive use of digital media is viewed as harmful or beneficial all relies upon how it is being utilized and for how long.

Technology has been shown to have its benefits. In moderation and with good intentions, technology allows for our brains to develop new skills and increase cognitive performance. A group of scientists led a study which looked at brain neural activation in cognitively normal adults. One group had minimal internet search experience, labeled the net naive group. The other set of people had extensive experience and were referred to as the net savvy group (Small et al., 2020). Both groups were subject to internet learning and stimulating activities. MRI scans were taken before and after. The net-naive group's scans showed that more parts of the brain were used and developed after being subject to the novel internet activities. The results of the net-savvy group were even better however as in the internet search task, this group displayed a more than twofold increase in the extent of activation in the major regional clusters compared with the net-naive group. The results imply that internet searching is a form of brain exercise. This suggests that even after continued use, digital media can still remain novel and offer a mentally stimulating experience (Small et al., 2020).

Brain scans can be examined to study attention and focus capacity in humans. A study that used neuroimaging developed scans of frequent and irregular internet users. In those people who routinely used the internet, the prefrontal cortex of the brain was twice as active compared to irregular internet users. This prefrontal cortex part of the brain is used for rapid decision making and short-term memory. Essentially, when there is a stream of information, we have developed the ability to skim, showing that technology in a way has allowed for our brain to develop new skills (Horvath, 2015).

This idea that using technology can enhance the brain's capacities is an extrapolation from the displacement hypothesis. In moderation, digital media can help develop the brain. However, the hypothesis implies that the harm of technology

comes from extensive exposure and is directly proportional to the use. Many of the negative effects attributed to technology use arise since people will forgo activities and interacting with others to instead spend more time on digital media (Przybylski and Weinstein, 2017).

In order to identify if youth are overusing digital media and therefore harming their brain development, an analysis of several regression models tested how engagement with digital screens was related to mental well-being, assessed with the Warwick-Edinburgh Mental Well-Being Scale. This is a 14-item self-report instrument validated for use in general population samples of individuals ages over 12 years that can measure the life satisfaction, psychological functioning, and social functioning of participants (Przybylski and Weinstein, 2017). The regression models showed an increase in mental wellbeing with technology use, rising until a peak at about two hours of use a day. Further engagement produced a negative correlation between daily digital screen involvement and mental well-being, often drastically decreasing around the 5-hour mark (Przybylski and Weinstein, 2017). Mental well-being is necessary for healthy brain development, so these models go to show how both limited and extensive technological use can inhibit proper cognitive growth.

Discussion

There is a limit as to the level of certainty researchers can ascertain technology as having a positive or negative effect. The vast majority of current neuroscientific research on digital media use relies completely upon self-reported characteristics. Although multiple testing factors can be introduced, i.e., the Warwick-Edinburgh Mental Well-Being Scale, people may not be reporting their data truthfully, which skews results. To combat this issue, neuroscientists should aim to incorporate larger datasets and use more refined methods to account for what happens on screens, for how long, and at what age. However, this raises questions of ethical measures and whether it is allowed for people to

be tracked to this extent, even with permission. Nonetheless, if these changes can be implemented, assertions made about technology use on brain development will have greater degrees of confidence.

In society today, technology can be beneficial. It allows for tasks to be accomplished with efficiency and flexibility. People can learn new skills and expand their knowledge. However, the misuse and overuse of technology causes problems. Although some people use technology in moderation, the reality is that the majority of users are abusing the time spent on the task at hand. In a study in 2018 from the University of Pennsylvania, participants were split into two groups. The first was set the task of limiting their social media use to moderate amounts, about 10 minutes per app; not cutting it out completely, but just enough to be informed and move on. The second group was told to continue using social media to the extent they normally do. The results showed that the limited group had significant reductions in loneliness and depression during the study compared to the other set of participants (Anonymous, 2021). This reduction in negative feelings allows for the brain to function normally and develop properly.

With more time in front of a screen, people are neglecting interactions with other humans, one on one. There is a limit of what one can learn from a screen. After a certain extent, real human connections are required in order to grow. Younger populations are extremely at risk as their brains are in the prime stage of development (Hutton et al., 2020). The extreme influence of technology will cause gaps in their knowledge and in other areas of life. Although youth are more susceptible to the problem, adults are not excluded from this risk. By growing up in front of screens, the youth brain is developing, but instead of making connections with other people and being put to good use, the time that could have been spent with peers, is instead used to interact with a screen. Developing brains are particularly vulnerable to this, and when exposed to high volumes of technology, the mind may adapt to

frequent visual stimulation and have little need for change (Anonymous, 2018). When many hours are spent playing games or browsing social media, some learning does take place, but after a while the brain is mindlessly reacting, and has reached a plateau in terms of growth. Any excess use with mindless actions will not be beneficial (Odgers and Jensen, 2020). These people will have certain skills with technology, but when it comes to being a member of society, they lack the necessary ability to contribute meaningfully. Although this might be an extreme case, it is becoming more prevalent in our world.

Technology is making up a larger part of our lives every day. Kids are growing up with screens in their hands. However, technological use cannot be labeled as simply good or bad (Hogenboom, 2020). The research accumulated goes to show that there are benefits and drawbacks to technology use. It is a myth that all use of digital media is bad and harms our brains. In the way it is being used today, technology is often being misused which leads to the misconception. For children in preschool, watching television has been found to have both negative and positive effects. Research suggests that educational television has a significant positive impact on cognitive development (Anderson and Subrahmanyam, 2017). Insufficient technology use can deprive younger people of digital interactions with peers and limit important social information that can be obtained. Overuse can displace time which could be used for meaningful activities (Przybylski and Weinstein, 2017). If one takes a step back, it can be realized how useful and beneficial technology is. We have dictionaries, quizzes, educational software, eBooks, games to expand cognitive growth, apps that can improve working memory and many other tools right at our fingertips (Resnick, 2018). "The dose makes the poison; it appears that both low and excessive use are related to decreased well-being, whereas moderate use is related to increased well-being" (Dienlin and Johannes, 2020). Digital media use is beneficial but has its drawbacks when overused

(Korte, 2020). The next step is to clearly identify the benefits of technology and attempt to expand on them, while trying to inhibit the drawbacks of digital media.

Conclusion

Multiple research studies have revealed that technology overexposure is affecting our brain health and it may be necessary to include restrictions, such as a change in the school code or implementation of laws to limit technology use to moderate amounts. With limitations on the extent of technology one can use, the brain can develop rightly and form connections with peers, a necessary part of growing up.

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