Online Multitasking in Teens: Impacts, Consequences, and Future Directions

Veronica Taira
Psychology - Relationships and Group Dynamics
Dylan Citrin Cummins

Abstract

This paper reviews the literature on the impact of online multitasking on the development of adolescents' attention. Media multitasking is the act of dividing one's attention between multiple media or online sites, ingesting large amounts of information in relatively short periods of time. According to the American Academy of Child & Adolescent Psychiatry, teens spend up to 9 hours on their phones daily.[1] Additionally, some teens spend up to 40% of their time online media multitasking - adding up to 3.6 hours of online multitasking if teens are spending 9 hours total online.[2] Social media has a profound impact on teenagers, and this paper aims to study what continuous exposure to different online media can do to teenagers. The literature review covers important studies that yield a large amount of information relevant to the research question.

Some of the studies examine how spending time on any part of the Internet can change our cognition - including attention span, working memory and executive functioning. Other studies explore the impact of media multitasking on overall mental health and well being. Several intriguing studies explore how media multitasking can affect the actual anatomic neurologic development of the brain. Finally, there are studies that explore (social psychology) associated with media multitasking.

These papers draw on research from cognitive tests of high media multitaskers, as well as scans of brain matter and activity, which will be presented in detail. Based on these findings, this paper urges teens to be wary of the time they spend online and the amount of media sites they interact with. This paper suggests that parents and teachers continue to educate their children and students about proper media usage and help children stay off screens. Lastly, a discussion of the role of social media site creators and their role in helping their users is conducted, with suggestions for lowering users' time spent not only on social media, but on the Internet as a whole.

I. Introduction

We live in a growing age of social media. Children and adolescents are being constantly exposed to digital media, websites, and all aspects of the Internet. We know the benefits: knowledge, connection, worldly experience. But what are the consequences? 97% of teens use social media as of 2022, and COVID19 has catapulted us further into the online world.[3] With online schooling, on

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[1] "Screen Time and Children." American Academy of Child & Adolescent Psychiatry. Last modified May 2024. https://www.aacap.org/AACAP/Families_and_Youth/Facts_for_Families/FFF-Guide/Children-And-Watching-TV-054.aspx.

[2] Xu, Shan, Zheng Wang, and Kelsey Woods. "Multitasking and Dual Motivational Systems: A Dynamic Longitudinal Study." *Human Communication Research* 45, no. 4. Oxford Academic.

[3] Vogels, Emily. "Teens, Social Media and Technology 2022." Pew Research Center. Last modified August 10, 2022. Accessed May 10, 2024.

average children 8-12 spent around 4-6 hours on screens, while teenagers spent up to 9 hours, relying on their electronic devices for social connection and learning.[4] Because this immersion into technology is so recent, research surrounding the effects of the internet on adolescents and children is limited. In order to fully understand the consequences, this paper sought to investigate the impact of online multitasking on adolescents' brain development and plasticity.

There are a wide range of options available to partake in when you open your computer or phone. Social media has increased these options exponentially, with access to short form videos on Tiktok, or the ability to swipe through multiple Instagram stories in a matter of seconds. 21% of teens almost always use forms of social media when doing homework, and 29% of teens use social media most of the time while doing homework.[5] Many say that it helps them focus, but there is very little evidence supporting this.There is increasing evidence that social media, like Instagram, can negatively impact a person's mental health, and the constant "follows" and "likes" and comments can damage the dopamine pathways in the brain, eventually becoming addictive.[6] So, being on multiple of these platforms all the time, continuously switching back and forth, realistically seems like it could have negative effects. In this paper, research is explored that investigates not only the psychological impact of media multitasking, but additionally, the cognitive and neurological impact, specifically focused on teenagers. The media multitasking index, or MMI, is used in studies in this paper to categorize levels of media multitasking across participants. A participant with a high MMI spends more time online multitasking than a participant with a low MMI. Implications of these studies and possible further action is also discussed.

Cognitively, media multitasking seems to impact areas like focus and memory, with psychological effects similar to the psychological effects of social media.[7] Neurologically, there is a limited amount of research, but the research that exists investigates the loss of gray matter in certain

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https://www.pewresearch.org/internet/2022/08/10/teens-social-media-and-technology-2022/.

[4] "Children's Internet Access at Home." National Center for Education Statistics. Last modified August 2023. https://nces.ed.gov/programs/coe/indicator/cch/home-internet-access.

[5] "The Common Sense Census: Media Use by Teens and Tweens." Common Sense Media. Last modified January 2015. https://commonsensemedia.org/sites/default/files/research/report/census_researchreport.pdf.

[6] Kuss, Daria, and Mark Griffiths. "Online Social Networking and Addiction—A Review of the Psychological Literature." *Environmental Research and Public Health*. National Library of Medicine.

[7] Uncapher, Melina, and Anthony Wagner. "Minds and brains of media multitaskers: Current findings and future directions." *Proceedings of the National Academy of Sciences of the United States of America*, October, 2018.

Uncapher, Melina. "Media Multitasking and Cognitive, Psychological, Neural, and Learning Differences." *American Academy of Pediatrics*, November 2017. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5658797/. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6176627/#r21.

areas of the brain, specifically the Anterior Cingulate Cortex. As MMI scores increased within participants, the ACC gray matter volume decreased.[8] With nearly 67% of teens engaging in multitasking behaviors, there is increasingly pressing need for examination of consequences.[9] This paper will review a series of studies about the many effects of media multitasking, and the consequences it yields for adolescents, in the hopes to educate people, especially teenagers, on the online world around them, including a discussion of implications for teens and adults, and possible further actions

add quote from anxious generation

II. Literature Review

Scholars and researchers have investigated the effects of social media, particularly media multitasking, on adolescents' cognitive changes and brain plasticity. Studies and meta analyses have shown that there are differences in the brains of high media multitaskers versus low media multitaskers, though the differences seem to vary from study to study. This section of the paper provides an overview of several key review papers on this topic.

A 2019 study review performed by Joseph Firth et. al, examined the effects of the Internet on our cognition. Firth et. al looked at attention span, memory, and human social connection in relation to the internet and digital world.[10] Explaining that the internet easily grabs and sustains our attention, Firth introduces the term "media multitasking", as a way to describe people that continuously interact with the multiple forms of media that we now have access to. Firth explains how studies have shown that people who participate in high levels of media multitasking perform worse at simple task switching abilities than their non multitasking counterparts - when presented with task switching trials, HMMs were slower to respond.[11] They're easily distracted by irrelevant stimuli around them. These media multitaskers require a greater cognitive effort to maintain focus, and some studies have shown that high levels of multitasking are associated with the loss of gray matter in prefrontal regions that are associated

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[8] Loh, Kep Kee, and Ryota Kanai. "Higher Media Multi-Tasking Activity Is Associated with Smaller Gray-Matter Density in the Anterior Cingulate Cortex." *PLOS One*. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4174517/.

[9] "Media Multitasking Among American Youth: Prevalence, Predictors and Pairings." *Key Findings*. https://www.kff.org/wp-content/uploads/2013/01/7593.pdf.

[10] Firth, Joseph. "The 'online brain': how the Internet may be changing our cognition." *World Psychiatry*, May 9, 2016. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6502424/.

[11] Ophir, Eyal, Clifford Nass, and Anthony Wagner. "Cognitive control in media multitaskers." *Proceedings of the National Academy of Sciences of the United States of America*, August 24, 2009. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2747164/.

with maintaining focus in the face of distraction.[12]

Firth then looks at the effects of the Internet on our memory - how the Internet could replace the need for different human memory systems, like our semantic, or factual memory. Furthermore, Firth describes the internet as a "supernormal stimulus" for transactive memory, a place where we can offload our memories and retrieve them in the blink of an eye.[13] And, even though we can access new information quickly, it doesn't mean that the information will be accurate, and it's significantly harder for us to recall it, even if we had just looked it up a minute ago. Online information gathering fails to recruit brain systems for long term memory and information storing.[14] Lastly, Firth et. al look at the impact of the Internet on the impact of social connection, specifically through the lens of online social networks. Firth explains that areas of the brain, like the amygdala, are similarly stimulated by online and real-life friendships and social situations. But, online social networks have become addictive; our brain receives a rush of dopamine in our reward system when we get new 'friends' online, and that continuous dopamine rush can form addictive patterns.[15] Overall, the researchers acknowledge that the internet can have detrimental effects on the brain systems of younger children and adolescents, but could possibly be beneficial for older people when used in the right way. Firth suggests further research into how we can harness social media and Internet sites in a beneficial way.

Melina Uncapher and Anthony Wagner performed a similar review of multitasking research in 2019, titled *"Minds and brains of media multitaskers: Current findings and future directions"*. Uncapher and Wagner examine both the cognitive and neural profiles associated with media multitasking, specifically those of young adults and adolescents. Examining studies on working memory, Uncapher and Wagner found that most studies show a negative connection between heavy multitaskers and ability to perform working memory tasks.[16, 17, 18] Similarly, there were perpetual

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[12] Zhou, Feng. "Orbitofrontal gray matter deficits as marker of Internet gaming disorder: converging evidence from a cross-sectional and prospective longitudinal design." *Addiction Biology* 24 (January 2019). National Library of Medicine.

[13] Ward, Adrian F. "Supernormal: How the Internet Is Changing Our Memories and Our Minds." *Psychological Inquiry* 24, no. 4 (2013): 341–48. doi:10.1080/1047840X.2013.850148.

[14] Sparrow, Betsy, Jenny Liu, and Daniel Wegner. "Google effects on memory: cognitive consequences of having information at our fingertips." *Science*, August 2011. National Library of Medicine.

[15] Goldman, Bruce. "Addictive potential of social media, explained." Stanford Medicine. Last modified October 29, 2021. https://scopeblog.stanford.edu/2021/10/29/addictive-potential-of-social-media-explained/.

[16] Cardoso-Leite, Pedro. "Technology consumption and cognitive control: Contrasting action video game experience with media multitasking." *Attention, Perception, and Psychophysics*. National Library of Medicine.

[17] Cain, Matthew. "Media multitasking in adolescence." *Psychonomic Bulletin & Review*. National Library of Medicine.

[18] Uncapher, Melina, Monica Thieu, and Anthony Wagner. "Media multitasking and memory: Differences in working memory and long-term memory." *Psychonomic Bulletin & Review*, April 2016. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4733435/.

filtering deficits when HMM(heavy media multitaskers) were faced with distractions and change (specifically visual and spatial changes).[19] Uncapher and Wagner also found studies suggesting that heavy multitaskers had reduced attention ability. High media multitaskers were numerically slower, and had a harder time with task switching than LMM(low media multitaskers).[20] Uncapher and Wagner examined two studies that looked at the underlying neurological effects of media multitasking. The first study observed the impact of media multitasking on gray matter volume in the anterior cingulate cortex (ACC) in HMMs, a cortex of the brain that is broadly responsible for cognitive control commands.[21] The second study compared the amount of time participants spent on social media to differences in their brain activity.[22]

A third review study, performed by Uncapher et. al, investigated the cognitive, social, psychological, and neural differences of people who were high media multitaskers. Uncapher begins by acknowledging the growing connection between media multitaskers (MMT), especially adolescents, and reduced performance on cognitive tasks - there's even evidence that shows cognitive differences when performing simple tasks.

In the cognitive profile studies that Uncapher et al reviewed, MMTs were often assessed in the domains of working and long term memory, inhibitory control, attention, and task management.[23] Heavier MMTs underperformed compared to lesser MMTs. That is further supported by the fact that attention-training can partially mediate the underperformance of heavy MMTs.[24] Psychologically, heavy MMTs have had a positive correlation with trait impulsivity. Neurologically, Uncapher et. al examined the same studies as Uncapher and Wagner, both yielding similar conclusions.

Uncapher et. al go on to examine media multitasking in the classroom. Many children growing up currently, require some sort of other media form in order to supposedly "focus" on homework and classwork (for example, music, or tv), identifying a study from Junco, Rynol, and Cotten suggesting

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[19] Vogel, Edward. "Neural measures reveal individual differences in controlling access to working memory." *Nature*, November 2005. https://doi.org/10.1038/nature04171.

[20] Unsworth, Nash, and Brittany McMillan. "Similarities and differences between mind-wandering and external distraction: a latent variable analysis of lapses of attention and their relation to cognitive abilities." *Acta Psychologica*. http://10.1016/j.actpsy.2014.04.001.

[21] Kee and Kanai, "Higher Media Multi-Tasking Activity Is Associated with Smaller Gray-Matter Density in the Anterior Cingulate Cortex.", 2014

[22] Moisala, M. "Media multitasking is associated with distractibility and increased prefrontal activity in adolescents and young adults." *NeuroImage*, July 2016. https://doi.org/10.1016/j.neuroimage.2016.04.011.

[23] Uncapher et. al, "Media Multitasking", November 2017

[24] Gorman, Thomas, and C. Green. "Short-term mindfulness intervention reduces the negative attentional effects associated with heavy media multitasking." *Scientific Reports*, April 2016. https://www.nature.com/articles/srep24542.

that the number of children that multitask when doing classwork lies at around 60%.[25] Uncapher explains that multitasking negatively affects academic performance, slowing down the ability to finish homework, and even negatively impacts the students' perceived ability to perform school work.

Like the previous studies, Uncapher et. all want future research to occur, focused on adolescents and developing minds, as well as research on interventions to remediate the effects of heavy media multitasking. Researchers hope that teachers and educators can give careful attention and consideration to online media use in their classroom, and for policy makers to advocate for increased funding that would go towards research goals.

III. Analysis of Scholarship

None of these review studies found a beneficial correlation between multitasking and brain development, while many of the studies evaluated found an adverse impact on brain development. Most of the negative impact on brain development involved the cognitive impact of multitasking. There is also emerging evidence surrounding potential adverse neurological effects, including several studies focused on the loss of gray matter and changes in neuron signaling.

Impact on Cognition

Multiple studies have investigated the cognitive effects of multitasking. In "Media multitasking and memory: Differences in working memory and long-term memory", Uncapher and Wagner found that high media multitaskers (HMMs) performed worse on both working memory and long term memory tasks.. Participants were required to perform a visual working memory task: remember the orientation of specific target rectangles in a sequence, and determine if the orientation had changed after viewing multiple other sequences. HMMs performed more poorly on recognizing changes in orientation of the targets, suggesting a decreased working memory ability. After that initial test, subjects were brought back to correctly identify previously encountered sequences, testing their long term memory. HMMs had a stronger bias to endorse new objects as previously recognized when they weren't on the primary test - in other words - it was harder for them to discriminate, suggesting a poorer long term memory than LMMs.

Pedro Cardoso-Leite et. al, had adolescents who were both HMMs and LMMs perform the AX-Continuous Performance Task.[26] Participants were presented with a sequence of red letters, and were required to press a specific 'YES' key if and only if the letter presented was a red 'X', and the

[25] Junco, Reynol, and Shelia Cotten. "Perceived academic effects of instant messaging use." *Computers & Education*, February 2011. ScienceDirect.

[26] Cardoso-Leite, P (2016). Technology consumption and cognitive control: Contrasting action video game experience with media multitasking. *Attention, perception & psychophysics*, *78*(1), 218–241. https://doi.org/10.3758/s13414-015-0988-0

previous letter was a red 'A'. All other sequences require the 'NO' button to be pressed by the participant. They found that HMMs had a lower accuracy, and took longer to examine the sequences and choose a response compared to the LMMs. This demonstrated impaired working memory of HMMs.

Another factor of cognitive ability often tested in media multitaskers was their ability to sustain attention, even in the face of distractions. A study by Ming Peng et. al, found that after Internet use (shopping online), compared to resting or reading, the attention scope of the study's participants was reduced compared to the non-using groups.[27] Participants that had engaged in Internet use had slower reaction when faced with divided tasks, proved not only by their reaction time, but by the lack of N2 - a wave component in the brain's electrical field, that's been found to indicate cognitive control. In a similar vein, Ophir, Nass, and Wagner's study found that HMMs couldn't easily filter out distractions or irrelevant stimuli. This inability to filter out distractions could lead to the reduced attention span that we saw in the HMMs from Peng's study.

On the other hand, a study by Ralph et. al, found no significant connection between media multitasking and attention span.[28] Testing self reporting media multitaskers, Ralph had participants perform the metronome response task, and the sustained-attention-to-response task. In 5 out of their 6 experiments, there was no negative relationship, with the first experiment initially finding a negative connection, but being replicated later, and yielding a null connection. It's important to note that this study was done by 'self-reported' media multitaskers, who might not necessarily fit the description of a multitasker used in other studies. Additionally, these experiments were done online, which leaves room for procedural error.

A study by Baumgartner et. al, found that early adolescents who participated in a lot of media multitasking had trouble with working memory, inhibition, and task shifting, but seemed to be better at avoiding distractions than non media multitaskers. The other study, performed by Cain et. al, found similar results with the 3 domains of executive functioning, but additionally, found that adolescents who were HMMs performed worse on academic Math and English testing. It could have been harder for the adolescents to switch between different aspects of each subject, but it is also possible that these participants were distracted by outside sources - contrasting Baumgartner's study, but supported by Uncapher and Wagner's first study.

A 2016 study by Brandon Ralph and Daniel Smilek used the *n*-back, a continuous performance task used to measure working memory, to examine the differences in working memory

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[27] Peng, Ming. "Attentional scope is reduced by Internet use: A behavior and ERP study." *PLOS One*, June 2018. National Library of Medicine.

[28] Ralph, Brandon. "Media multitasking and behavioral measures of sustained attention." *Attention, Perception, & Psychophysics*, October 2014. https://link.springer.com/article/10.3758/s13414-014-0771-7.

ability between heavy MMTs and lower level MMTs.[29] 317 participants first completed the original media multitasking index, to measure their level of multitasking in everyday life. Using both 2-back and 3-back tests, participants were presented with a sequence of stimuli, and needed to decide whether the stimuli just presented was the same as the one presented 2 or 3 trials ago, hence the name 2-back and 3-back. Ralph and Smilek manipulated the memory load (2-back versus 3-back), the type of stimulus, and the type of sequence, with 48 trials for both 2-back tests and 3-back tests. After completing these trials, participants completed a slightly different media multitasking index, and a compliance check. The study found a 'robust' relation between participants with higher levels of media multitasking, and 'false alarms' on the *n*-back test - parts of the sequence that participants identified as a target stimulus that were not targets. Heavy media multitaskers also had poorer sensitivity to different stimuli during both tests. Ralph and Smilek concluded that the higher the media multitasking index was for the participant, the worse they would perform on the *n*-back tests, suggesting some decreased working memory ability in high MMTs.

Minear et al measured impulsiveness and intelligence of high media multitaskers.[30] The study included 221 college students, and sent out 3 surveys: the Multi Media Index, the Barratt Impulsiveness Scale, and the Self-Control Scale - meant to measure an individuals' perceived self control. Participants then took 3 laboratory tests. The first measured fluid intelligence, a nonverbal reasoning task where participants essentially completed different matrices, sequences, and puzzles. The second test measured the reading span of the participant - remembering the final word of each sentence in a series, meant to measure working memory capacity. The final test measured task switching ability, taken from Ophir's 2009 study on cognitive control in media multitasking.[31] This study found that HMMs reported higher levels of impulsivity, and performed worse on intelligence tests.

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Impact on Mental Health and Wellbeing

While research on the psychological impact of multitasking is slightly limited, from existing research high amounts of media multitasking still seem to be impactful.

Roy Pea et. al performed a study evaluating media multitasking and social well being in 8-12 year old girls through an online survey. Pea found that negative social well being (social connectedness, satisfaction, etc) was associated with high levels of media use.[32] Conversely, face to face interaction

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[29] Ralph, Brandon, and Daniel Smilek. "Individual differences in media multitasking and performance on the n-back." *Attention, Perception, & Psychophysics*. Springer Link.

[30] Minear, Meredith. "Working memory, fluid intelligence, and impulsiveness in heavy media multitaskers." *Psychonomic Bulletin & Review* 20. https://link.springer.com/article/10.3758/s13423-013-0456-6.

[31] Op3hir, Eyal, Clifford Nass, and Anthony Wagner. "Cognitive control in media multitaskers." *Proceedings of the National Academy of Sciences of the United States of America*, August 24, 2009. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2747164/.

[32] Pea, Roy. "Media use, face-to-face communication, media multitasking, and social

yielded higher levels of positive social well being. Becker, Alzahabi, and Hopwood found that high media use was associated with higher levels of anxiety and depression, increased in HMMs that were teenagers by 15%, even when controlled for each person's specific traits.[33] But, those levels are self reported, and may not have been in accordance with medically defined clinical anxiety and depression. Sanbonmatsu et. al performed a study measuring multitaskers' abilities, and found higher levels of impulsivity with increasing media multitasking index(MMI).[34] This impulsivity could be a result of high exposure to multitasking, but could also be a trait of people that are drawn to multitasking.

The Anxious Generation, a book written by Adam Alter, explains how the defining statistics of social media (likes, followers, views, etc), can continuously activate your brain's dopamine system in short bursts, making it addictive.[35] As he says in his summary of Chapter 5, dopamine release isn't a satisfactory feeling - it makes one want more of whatever triggered the release. Developers of social media sites, including Instagram, use behaviorist techniques to hook their users - encouraging heavy use of these sites, and possible risk of addictive behaviors. The addictiveness of the Internet can lead to online multitasking - people have to continuously look up ideas, and check their social media accounts, and the addictiveness of this behavior makes it hard for them to stop. This social aspect of the Internet can also lead to a decline in mental health; people measure themselves against the number of likes or followers they have, and base their feelings off of those numbers.

Impact on Neurologic Development

While research predominantly focuses on cognitive impacts of media multitasking, it's relevant to focus on the underlying neurological impact as well, as it can lead to further cognitive effects. In 2016, Moisala et. al performed a study on a group of 149 adolescents to see if there are actual differences in neurologic brain activity between high and low media multitaskers.. While measuring brain activity, Moisala had participants perform tasks while being distracted, or perform task-switching. In the presence of a distractor, people that participated in higher levels of media multitasking performed worse on both tests, and had increased brain activity in the right prefrontal regions. The prefrontal cortex facilitates sustained attention, switching between behavioral patterns, and behavioral inhibition,

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well-being among 8- to 12-year-old girls." *Developmental Psychology*, March 2012. https://doi.org/10.1037/a0027030.

[33] Becker, Mark, Reem Alzahabi, and Christopher Hopwood. "Media multitasking is associated with symptoms of depression and social anxiety." *Cyberpsychology, Behavior and Social Networking*, February 2013. https://doi.org/10.1089/cyber.2012.0291.

[34] Sanbonmatsu, David. "Who multi-tasks and why? Multi-tasking ability, perceived multi-tasking ability, impulsivity, and sensation seeking." *PLOS One*, 2013. https://doi.org/10.1371/journal.pone.0054402.

[35] Alter, Adam. *Irresistible: The Rise of Addictive Technology and the Business of Keeping Us Hooked*. London, England, 2017.

along with other cognitive controls.[36] The fact that media multitaskers had a higher level of activation in these sites suggests that the brain was working harder to control and activate these actions like focusing, and ignoring distractions, unlike the brains of adolescents who didn't participate in high levels of online multitasking.

There is strong ecological validity in Moisala's study - the task switching and multitasking that participants had to do exists in the real world. Reading in the face of distraction, and listening to multiple different sources can be seen in school and workplace environments.

The impact of multitasking on brain structural development was evaluated inLoh and Kanai's study, "*Higher Media Multi-Tasking Activity Is Associated with Smaller Gray-Matter Density in the Anterior Cingulate Cortex*". Loh and Kanai studied the anterior cingulate cortex (ACC). The ACC is connected to the prefrontal cortex, and facilitates inhibitory control, as well as emotion regulation and decision making. But, Loh and Kanai didn't measure activation like Moisala et. al - they measured the loss of gray matter (the death of neurons). Loss of gray matter can lead to inability to function, as the death of neurons destroys neuronal pathways and inhibits communication in the ACC. Loh and Kanai found that participants that scored higher on the MMI, had small gray matter density in the ACC, suggesting a possible connection between heavy media multitasking and decreased cognitive performance.

Impact of Social Psychology

The easiest impact to connect to social psychology is the psychological impact of multitasking. The ideas from Social Identity Theory and Conformity Theory can help explain why people are drawn to social media, and why it becomes psychologically addictive.

Social Identity Theory states that individuals want to improve their self esteem, and they do so by belonging to certain social groups. People will categorize themselves into an 'in-group' and view other social groups as 'out-groups', tending to favor their own. Social media has provided spaces for all social groups to find others like them, which allows people to improve their self esteem. Being on multiple different social media sites with multiple different groups that one identifies with (online multitasking), probably serves to increase one's self esteem. Additionally, this abundance of identity groups has made it easier for people to disparage groups seen as 'out'. Cyber bullying, and anonymous comments on social media posts can be used to make fun of people that don't fit supposed social norms. Being constantly exposed to these ideas of 'in' and 'out' groups constantly through multitasking, can solidify these ideas into one's brain - making them more likely to rely on their 'in-group' for self confidence, and more likely to make fun of 'out-groups' that they don't identify with.

[36] Moisala, "Media Multitasking is associated with increased distractibility", 2016

IV. Implications

The teenage brain is changing, restructuring, and developing until around the age of 25.[37] The connections between different regions of the brain are still developing, making them very susceptible to change. The introduction of social media into the teenage world is new and ever expanding, and while we know some of the short term effects, the long term effects of this media usage are still unfolding. The research covered in this paper is important because it can give scientists and teenagers clues of possible long term effects and direction towards how to avoid long term consequences.

Need to Increase Adolescent Awareness

Because many cognitive and neurological processes aren't innate, but mostly influenced by environmental factors, it's important to consider the positive and negative effects of media multitasking, and how it can change the brains of adolescents in the current world and in the future.[38] One of the most worrisome effects of long term, continuous exposure to media is brain abnormalities. Long term internet usage or addiction alters the structure of adolescent's brains - not only changing neural reward pathways (making the Internet a shortcut to dopamine release, increasing addictability), but reducing the volume of gray matter - killing the neurons in your brain.[39] Teenagers have to be aware of these consequences, because it's extremely hard to rewire reward pathways, and there isn't any way to gain back the lost gray matter. While teens lose small amounts of gray matter until their brain is fully developed, heightened loss can cut off important connections before those connections have fully developed.

Teenagers should also be aware of the impact of media multitasking on attention span. As said previously in the paper, media multitasking can lead to a reduction in attention span, and a tendency to be easily distracted. Teens should be wary about the time they spend on social media, and the amount of online information they can ingest in just a couple of hours, because it can potentially hurt their ability to perform in a college and workplace setting.

Community Implications

In the Menlo community, social media use is very prevalent. Menlo School Instagram page, and the many Menlo sports Tik Tok accounts, move a portion of the Menlo community completely online. When finding information about the school, students switch from media to media, even using

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[37] Arain, Mariam. "Maturation of the adolescent brain." *Neuropsychiatric Disease and Treatment*, April 2013. National Library of Medicine.

[38] Firth, "The 'Online Brain'", 2019

[39] Yuan, Kai. "Microstructure Abnormalities in Adolescents with Internet Addiction Disorder." *PLOS One*. https://doi.org/10.1371/journal.pone.0020708.

Canvas on their computers to get more information. Spending 4 years switching from media to media, as Menlo moves even more online, may be detrimental to students' classroom abilities and wellbeing - as suggested by the research in this paper. The gained efficiency of being online may not justify the loss of real, in-person community. The media accounts should not be completely deleted; they do have many benefits. Rather the Menlo community as a whole could make an effort to prioritize face-to-face connection. Sports, clubs, and grade leaders can interact more with other students on the quad, or at sports games. It might be best if social media was not the main place of interaction. By keeping the internet as an add-on to regular social life, teenagers both inside and outside of our community could limit the harmful effects of media multitasking - while maintaining the benefits that online communities provide.

*anxious generation → add footnote *

The Role of Parents

Given the potential impact of social media on adolescents as outlined in this paper, it is reasonable that parents should be thoughtful about the possible impacts of social media, especially media multitasking, on their developing children. Technology is needed for children to perform in school and workplace settings, but the question is: at what age should children be exposed to such technology? Because of the risks we described, some have argued that parents should try and wait as long as possible to give their child access to social media, because exposing children too early to the overload of information online, and the possible psychological effects, can be detrimental to their development.[40] Some think that around 8th grade, or at ages 13-14, is when a child (on average) is mature enough to handle the basics of social media.[41] However research on this is lacking, and the long term implications of extensive social media use have yet to be determined.

The Role of Educators

While teachers don't have the same role as parents, they are important when it comes to the development of children. Currently, many school assignments are online, forcing students to switch between assignments, and spend hours on their computers each night. As said previously in this paper, constantly multitasking can have a negative effect on cognitive areas of the brain, making it even harder to do the homework that students might have been assigned.[42] Instead of having all of their assignments online, teachers could implement offline activities - both in class and out of class.

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[40] Jackson, Ashton. "RAISING SUCCESSFUL KIDS: Want to raise happy, successful kids? 'Wait as long as possible' to give them a phone, says Yale expert." CNBC. Last modified October 23, 2023. Accessed May 8, 2024. https://www.cnbc.com/2023/10/23/wait-as-long-as-possible-to-give-kids-a-phone-yale-psychology-expert.html.

[41] Miller, Caroline. "When Should You Get Your Kid a Phone?" Child Mind Institute. https://childmind.org/article/when-should-you-get-your-kid-a-phone/.

[42] Uncapher, "Media Multitasking", 2017

Classwork like group brainstorms or discussions are helpful to kids, both academically and socially, and can replace online browsing and multitasking in the classroom. Teachers should also participate in helping train children about media safety - whether it's educating them about Artificial Intelligence, or just explaining to them how different social media sites work, words from a trusted educator can go a long way.

Like parents, teachers should cultivate an inclusive classroom that's safe for all students. Many people look for "in-groups" online, because they can't find any in their own life, but teachers can help create in-groups for all different sorts of students. By creating an open classroom, students can come to talk to their teachers and peers, without the use of social media. It gives them the opportunity to identify with a group, without the negative psychological and cognitive effects getting in the way.

Responsibility of Leaders of Social Media Platforms

As people who are heavily influencing the next generation, the leaders of social media platforms could adjust their view on the business of media and marketing to address some of these issues. From studies in this paper, we know that social media usage is addictive, and can lead to impulsive and addictive behavior.[43] These sites were constructed with the purpose of getting adolescents and children hooked, because continuous usage of their platforms gets the leaders more money and recognition. There is a competition for attention as soon as one opens their phone - media sites sponsor ads, and promote their businesses relentlessly. Social media sites should be created with the goal of fostering positive connection and communication - not with the primary goal of gaining more users and more income.

Leaders of Tiktok or Instagram shouldn't idolize unrealistic standards of living or of self image - but instead should be created with the goal to lift users up. Focusing more on communities, or social media groups, instead of famous or infamous individuals will help users immensely. Short form videos shouldn't be as prevalent on different platforms, because of their adverse effect on our reward system, and how easy these videos make it for adolescents to multitask between different media sources. These platforms should have reliable information sharing, and easy availability for connection with others - but monitored connection so that children of all ages can feel safe on different social media sites.

These options might not look like money grabbers, but overall should be considered. But what should also be considered, is if these platform leaders should be where we go to make change. Many of the ideas presented in this section would benefit users, but not necessarily the company, and discussion of both sides could ultimately have an unsatisfying outcome for both parties.

are there possible incentives for creators to do the right thing?? (+/- incentives

[43] Sanbonmatsu, "Who multi-tasks and why?." 2013.

Final Reflections

As teens, parents, and educators, we have a responsibility for ourselves and others. While social media brings forth a wealth of amazing information, people, and discoveries, we can't ignore its negative effects. Media multitasking is becoming ever more present with teens, and in school environments, and the cognitive, psychological and neurological effects shouldn't be ignored. We need to find ways to take in information, but not at a level where it hurts the functioning of our brain. With the rise of Artificial Intelligence, people are turning to the Internet as a way to solve their problems, increasing the amount of time they spend online, and increasing the risk of consequences. As humans, we want as much information as we can get, and the Internet offers a seemingly unlimited source of information. However, we can't find a way to live offline, then in the future, the Internet could have more control over our lives than we could have originally imagined - at the expense of diminishing our ability to function to our full potential in the actual physical world. It's important to be wary about the time and effort we put into our online media sites and profiles, and it's important we learn how to spend time away from the screen - so that we can function at our full potential in both the online and physical worlds

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