



Unraveling the Neurochemical Relationship Between Social Media and Attention Span

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Abstract

Social media has become integrated into our daily lives and leaves an impact on our attention and self-control. Because of the popularity of short-form content, it has led to major deficits in attention span. Understanding the changes in brain chemistry enables people to improve their attention and mental health. In this paper, we explore dopamine pathways and other neurotransmitters' relationship with attention and social media addiction. Depending on which generation a person is part of, the possibility of different groups becoming addicted to social media can vary. Here, we analyze the differences in social media usage in young versus aged individuals and how their brain chemistry differs depending on their usage. We have found that younger generations who have grown up with social media have an increased tendency to addiction and reduced attention span. This is due to altered dopamine release which feeds into pathways of addiction, affecting one's attention span. As older individuals use social media less overall, they are not as affected by social media addiction and have fewer deficits in attention span. Many of these topics are interconnected with one another and further exploration of these overlapping subjects of neural mechanisms can lead to methods for improving the impacts of social media addiction on people.

Introduction

Social Media has become a vital aspect of our everyday lives, as we continue to live in a progressively digital era. Popular platforms such as TikTok, YouTube shorts, and Instagram reels have enabled individuals to continuously watch endless content while allowing creators to distribute content that entices them and their followers. This content is often called "short-form" content, these videos are usually 15 minutes or less. Some creators have used these platforms to reach a wide audience, allowing creators to gain millions of views. From January 2018 to November 2022, short-form content platforms, such as TikTok, were downloaded by over 4 billion people. (Xie et al., 2023). This huge imprint in the short span of four years has left our society adapting to constant social media use. These platforms have become integrated into our lives in multiple areas. Social media has provided individuals with a medium to communicate and interact with others across the globe, leading to an expansion of social networking and facilitating more efficient communication. Despite the multiple positive aspects that social media has brought us, one consistent trend that has shown through the years is the transformation in the way we interact with others. Past studies have found that increasing use of social media has led to less face-to-face interaction, neglecting in-person interactions that hold intimacy (Azzaakiyyah, 2023).

The rise of social media use has led to multiple threats to one's mental health, social life, and physical health (Xie et al., 2023). Research has shown that many interactions on online platforms have been linked to self-harm and suicidal thoughts because of the intensity and frequency of these online interactions that could lead to cyberbullying. In a study, over 400 youth were hospitalized due to the risk of harm to others or themselves. Social media has also been correlated with social comparison. Users often engage in "selective self-presentation" on these platforms to display themselves positively. This may lead to their audiences comparing themselves in terms of their accomplishments, abilities, and looks (Nesi, 2020). The purpose of this paper is to educate readers on the impact of social media on one's attention span due to the potential risks of social media usage to an individual's mental health. Furthermore, we will

evaluate the impact of social media by exposing more extensive cultural shifts and trends in communication and information consumption that could reflect on behaviors. There has been little research conducted on attention span and its relationship with social networking platforms. Cumulating information on dopamine's involvement in the process of attention span and how social media addiction is intertwined with one another can allow researchers to find effective ways to improve attention span.

Attention Span on the Brain

The brain is a very complex aspect of human anatomy and is essential for humans to not only live but to function in society. The brain is full of networks that are communicating through neurons. These neurons in the brain and nervous system release chemicals called neurotransmitters which play a key role in the brain's ability to function and regulate the body (Nair et al., 2023). The constant use of social media and the popularity of short-form content is prone to addiction. This trend is particularly noticeable in students and adolescents. Due to the nature of short-form content, they are designed for their audience to continue watching short videos endlessly, which could keep individuals watching for long periods of time (Xie et al., 2023). The increasing use of social media has raised concerns about one's attention span. The addictive nature of social media has suggested that short-form content impacts an individual's ability to stay focused on a task and their duration of concentration (Xie et al., 2023). Attentional control is a major factor in an individual's ability to concentrate on tasks. Attentional control is a cognitive function that regulates the distribution of attention and its connection to executive control (Xie et al., 2023). Studies have shown that content often provided on short-form video platforms typically causes strong excitement in the brain, leading to an increase in cognitive resources for information processing and a more consistent shift in attentional focus. This creates low attentional control and those who experience this find it more difficult to focus on tasks, leading to individuals being more prone to distractions and external stimuli despite their intentions (Xie et al., 2023). Students have reported that their consumption of social media has impacted their attention span and their ability to focus for long durations of time (Asif & Kazi, 2024). Additionally, research has shown that a decrease in executive control leads to an increase in motivation-seeking and craving. Imbalance systems cause individuals to be more likely to prioritize short-term satisfaction for reduced cravings and overlook long-term goals (Xie et al., 2023)

The issues surrounding a lack of attention span can be attributed to the neural transmitters and mechanisms involved in these processes. Dopamine (DA) is a neurotransmitter that is often called the "pleasure hormone" or the "reward chemical" that is released in mechanisms, such as pacemaker firing, that influence the activity of other neurons (Costa & Schoenbaum, 2022; Wise & Robble, 2020). It is crucial to nearly all cognitive functions of the brain. These functions include motor control, motivation, and learning (Costa & Schoenbaum, 2022). DA is also categorized as a neuromodulator, which is a subgroup of a neurotransmitter, that adjusts how sensitive neurons can be to other neurotransmitters, rather than replacing them (Wise & Robble, 2020). DA is often found in the striatum, which has multiple subdivisions (Costa & Schoenbaum, 2022). The effects of DA on behavior and functions are dependent on two main receptors, D1 receptors and D2 receptors. D1 receptors in the brain are found in the supragranular layers (visual cortex) and the infragranular layers (prefrontal cortex). D2 receptors are located in the infragranular layers and are more involved in the motor outputs. The primary pathways are in two areas, the ventral tegmental area and the substantia nigra (Thiele &

Bellgrove, 2018) The ventral tegmental area's primary role is associated with reward processing and decisions. While the substantia nigra is involved in motor control and attention (Thiele & Bellgrove, 2018), dopamine has been found to contribute to spatial attention and target selection in the frontal cortex. Research has found that dopamine influences how animals choose situations where targets appear at different times. During these situations, dopamine receptors are inhibited or activated in certain regions of the brain which shifts an animal's attention, demonstrating how dopamine directly affects decision-making and where we choose to focus our attention in our environment (Thiele & Bellgrove, 2018). DA also plays a key part in an individual's motivation which leads to reward (Berke, 2018). In the dopamine system, pacemaker firing, which is a repeated independent discharge that is triggered by depolarizing current within the dopamine neuron, plays a role in one's motivation (Wise & Robble, 2020). In humans, increasing DA levels enhances motivation. Studies have shown that animals with higher DA levels tend to show a willingness for more desirable rewards. Therefore, it demonstrates that dopamine is essential for driving goal-directed behavior and how much effort an individual is willing to pursue a reward (Wise & Robble, 2020).

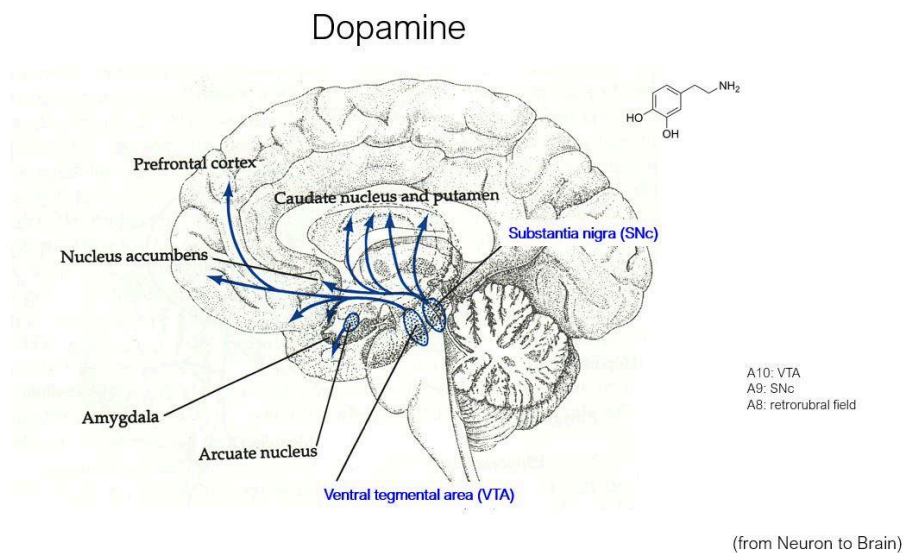


Figure 1, Dopamine pathways

Note. Diversity of dopamine neurons, Sainsbury Wellcome Center, 2019, Accessed on October 2024,

<https://www.sainsburywellcome.org/web/qa/diversity-dopamine-neurons>

Interestingly, dopamine isn't the only neurotransmitter involved in one's attention span; transmitters such as acetylcholine (Ach) receptors are involved. Ach has a major presence in the prefrontal, parietal, and visual regions of the somatosensory and often acts as a neuromodulator (Klinkenberg et al., 2011; Picciotto et al., 2012). Acetylcholine receptors are influenced by DA levels but often work together to regulate transmissions of signals to the brain's information processing network and a "microcircuit" of the brain that allows a person to pay attention (Nair et al., 2023). In the brain, Ach influences the cortical networks on multiple levels in the prefrontal cortex. The basal forebrain (BF), plays a role in maintaining attention. When Ach is released from the BF, it floods major regions in the cortex. This is critical for sustained attention and executive functions. Ach has been shown to correlate with cue detection

in attention tasks. Studies have shown that in the medial prefrontal cortex, the stimulation of nicotinic receptors enhances the performance of visual attention tasks (Picciotto et al., 2012). Furthermore, Ach strengthens sustained attention by increasing the “signal to noise” ratio in cortical networks. These neurons are more responsive to relevant signals and suppress distractions. This selective attention system allows an individual to focus better on certain tasks (Picciotto et al., 2012). Both of these receptors are interconnected with one another and often play a role in a person’s motivation to stay focused, reinforcing the behavior of either a longer or shorter attention span.

Social Media Usage and Attention Span

One popular form of social media known as short-form content is provided on multiple platforms: such as TikTok, Instagram, YouTube, and Snapchat, and has reached over 962 million people in 2022 (Xie et al., 2023). Through these platforms, users are allowed to create videos that cover multiple aspects of their lives. This could include cooking, hobbies, lifestyle, and more. Additionally, users on these platforms can browse and like others’ videos to interact with each other (Mu et al., 2022). These mediums also use complex algorithms that tailor to specific audiences to keep them engaged. These algorithms provide users with personalized content based on an analysis of their preferences and interests (Mu et al., 2022). According to studies, TikTok has 486 million monthly active users and around 22% of these viewers watched videos for more than one hour a day in 2022 (Mu et al., 2022). This has highlighted the excessive use of social media by many adolescents and teenagers, resulting in both negative and positive outcomes. Online platforms led to major shifts in human interaction and communication. Studies have seen changes in social interaction while also reporting an expansion in social networks and the facilitation of more efficient communication. Furthermore, social media has transformed individuals' ability to establish friendships with others across the globe. The easy access to communication between people has facilitated cultural exchange (Azzaakiyyah, 2023). Despite the positive aspect of efficient communication for those across the globe, for others, it has had the opposite effect. Some individuals have begun to experience social isolation because they are constantly watching their devices which has led to less face-to-face interaction (Azzaakiyyah, 2023). Mentally, it has been studied that excessive use of social media has led to an increase in depression, distractions, low sleep quality, decreased happiness, academic burnout, parent-child relationship quality, and perseverance (Mu et al., 2022; Xie et al., 2023).

Social networking platforms provide users with unpredictable awards. Many never know if their next notification or message will give them a feeling of happiness (Griffiths, 2018). Social media is a type of behavioral addiction that has similar characteristics as other addictive substances; such as drugs, alcohol, and cigarettes (Li et al., n.d.). The rewards provided by the internet are often associated with the expectation of a reward that can be psychologically and/or physiologically pleasing. Many researchers refer to this as variable reinforcement schedules, which is one of the main contributors to users repeatedly using their devices (Griffiths, 2018). A variable reinforcement schedule is the promotion of repetitive response patterns to stimuli over time, which are often resistant to behavioral extinction. (Griffiths & Nuyens, 2017). When an individual posts or shares something on social media, the expectation to receive a notification on their phones increases levels of anticipation (MaciT et al., 2018). Many individuals often expect a buzz, ring, vibration, or ping of an incoming message or notification. This acts as a stimulus that enables people to look at their devices in hopes of seeing what has been sent to

them (Griffiths, 2018). The feeling of anticipation leads to a rise in DA levels but then begins to quickly decrease after the sensation of “satisfaction” is experienced. Then the brain starts seeking the same feeling of pleasure again. This results in people constantly feeling the need to look at their devices again, creating an endless dopamine cycle, as shown in Figure 2 (MaciT et al., 2018).

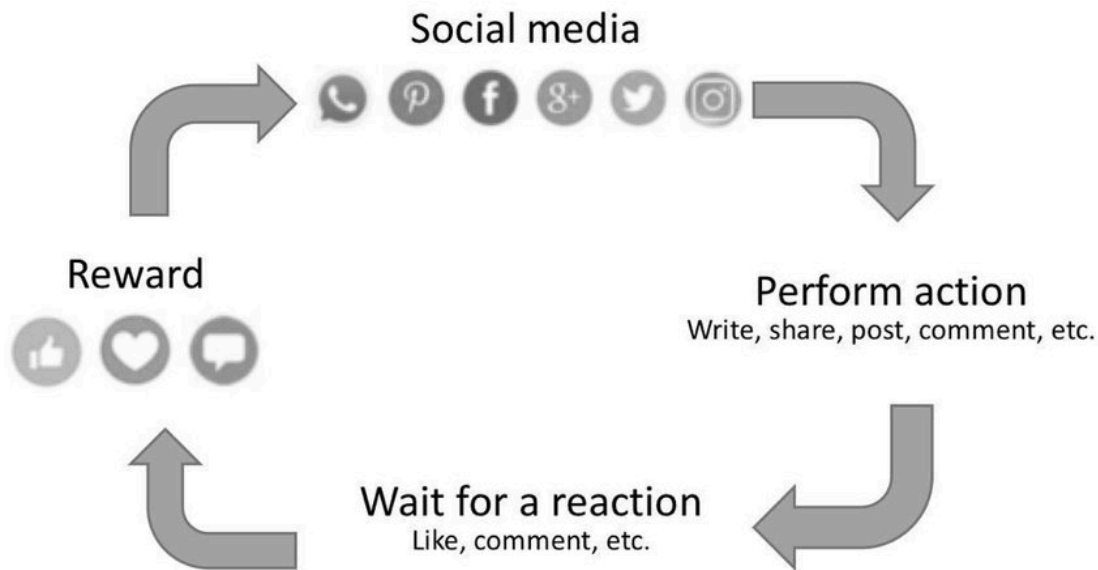


Figure 2. Social Media dopamine cycle

Note. Adapted from “A RESEARCH ON SOCIAL MEDIA ADDICTION AND DOPAMINE DRIVEN FEEDBACK” by Maci T, H. B., Maci T, G., & Güngör, O, 2018, Mehmet Akif Ersoy Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 5(3), p 892 (<https://doi.org/10.30798/makuiibf.435845>)

This endless dopamine cycle of social media addiction also affects the other cognitive functions of the brain. DA plays a key role in one’s motivation and the brain’s reward system. In the reward system, the stimulation of social media addiction gives quick rewards with a short delay that causes motivation to look for the same levels of dopamine again, causing addiction-seeking behaviors (MaciT et al., 2018). As mentioned before, when a person is expecting a reward, their DA levels begin to rise in anticipation. The motivation to pursue the reward that social media provides increases, making a person more focused on going back to social media. (Berke, 2018). Furthermore, studies have shown that highly engaging content typically initiates strong excitement in the brain. This results in the use of DA and acetylcholine in the brain and low attentional control. Those with low attentional control often find it more difficult to focus on tasks and are more prone to distractions and external triggers in their surrounding environment despite the intention to concentrate on their intended obligations, resulting in a reduced attention span because of social media addiction (Xie et al., 2023). The influence of social media has not only left society constantly looking at their devices but it has also reshaped our attention span and self-control in ways that we are just grasping an understanding of.

Impact of Social Media on Different Ages

The way people use social media differs between age groups. Younger generations are the most influenced by social media. Studies have shown that 93% of teens between the ages of 12 and 17 use social media, making them the largest audience (Li et al., n.d.). According to Pew Research Center's 2021 U.S. study, in 2021, 84% of adults between the ages of 18 to 29 reported using social media (Auxier & Anderson, n.d.). Along with the rising use of social media for the younger generation, middle-aged adults are also at similar percentages of usage. However, their usage is dependent on their communication with their family and colleagues (Li et al., n.d.). Around 81% of those aged 30 to 49 reported using social media while an estimated 73% of people aged 50-64 years and 45% of those 65 or older reported use (Auxier & Anderson, n.d.). However, the way these age groups utilize social media is dependent on the platform they use. The majority of those between 18 to 29 years old document using Snapchat (75%) and Instagram (76%), while also about half of them report using TikTok (55%) in 2021. (Auxier & Anderson, n.d.). In contrast, older age groups have a striking difference in usage of platforms that provide short-form content. Only 2% of adults aged 65 and older have reported using Snapchat, a gap of 63 percentage points. The most popular platforms amongst the older generation are YouTube (49%) and Facebook (50%), showing a major decreasing trend (Auxier & Anderson, n.d.).

In terms of the neural mechanisms in each of the different age groups, the younger generation is more prone to social media addiction. This is due to teenagers' strong sense of curiosity, social tendencies, and thirst for learning (Mu et al., 2022). The excessive usage of their devices among adolescents highlights their immature abilities of self-control and psychological needs (Mu et al., 2022). This results in difficulties when it comes to maintaining good self-control. The lack of self-control is based on their habitual use of social media and their risk-taking behavior (Griffiths, 2018; Li et al., n.d.). The potential risks of social media usage for adolescents have only grown since 2022. Short-form content has been linked to the rise in negative issues. This includes increased depression, distractions, low sleep quality, and social isolation (Mu et al., 2022). In contrast, many middle-aged adults use the Internet as a way to communicate with their family and colleagues. Hence furthering their connections and relationships with others. The elderly group often uses social media as a networking platform to build connections. It has been reported that approximately 43% of elders 65 years and older feel loneliness, which is linked with their health status and increased rate of death (Li et al., n.d.). The usage of these platforms represents the different trends and popularity of these online mediums bringing awareness to the excessive use of media in the younger generation.

Discussion

This review aims to explore the impact of social media on addiction and attention span pathways and how these have a relationship. This analysis highlights consistent evidence that dopamine levels increase during social media usage which causes deficits in attention span and motivation outside of the digital world. Dopamine's notable name as the "pleasure hormone" or "reward molecule", influences behaviors and cognitive functions, specifically attention and addiction (Costa & Schoenbaum, 2022). Dopamine has been found to play a key function in spatial attention and target selection in the brain. Research has shown that dopamine influences how we make decisions on where we choose to focus our attention (Thiele & Bellgrove, 2018). Many students have reported that due to their engagement on short-form content platforms,

they have a significant decrease in their ability to focus (Asif & Kazi, 2024). Students have also reported that they can't concentrate for long periods without getting distracted, indicating that short video usage affects their ability to sustain attention (Asif & Kazi, 2024). In sustained attention, acetylcholine often influences DA levels which renders one's ability to maintain a balanced "signal to noise" ratio. When individuals have a balanced "signal to noise" ratio, Ach levels are increased in cortical networks, as these neurons strengthen one's ability to be responsive to signals and suppress distractions (Picciotto et al., 2012). Simultaneously, dopamine levels are increasing because of independent discharges from the dopamine neuron, called pacemaker firing which enhances one's motivation to feel "satisfaction" (Wise & Robble, 2020).

These dopamine pathways of attention are associated with our habitual use of social networking and our motivation to focus on a certain task. As mentioned before, having a habit of constantly checking your device facilitates social media addiction (Griffiths, 2018). When an individual posts something on social media, the expectation to receive a notification on their phone increases levels of anticipation. This leads to a rise of dopamine levels and these levels begin to rapidly decrease after the sensation of "pleasure" is experienced. Then the brain starts to search for the same feeling again. The individual constantly thinks about experiencing the same sensation over again and gaining motivation to look for the same feeling, causing a dopamine addiction cycle (MaciT et al., 2018). This constant thought and the need to check social media to see if your friend has commented on your post creates a distraction when trying to focus on a certain task.

The use of social media has varied amongst different age groups, however, a common trend among these reported usage is that the majority of these groups use short-form content platforms. Various papers have shown that the younger generations are most involved in digital networking across platforms. This is due to multiple reasons, such as their curiosity and social tendencies, resulting in their difficulty in self-control (Li et al., n.d.). This concept has been well characterized in other studies showing that teens engage in riskier behavior compared to older individuals, such as alcohol or drugs. (Li et al., n.d.).

As the use of social media continues to grow in popularity, the rise in potential risks of excessive use continues. It has been claimed that the growing impact of social media usage amongst the younger generation has affected their ability to concentrate on tasks and being able to maintain a stable attention span. Many students ranging from the ages of 12 to 29 years old have developed an addiction to social media (Li et al., n.d.). In turn, this affects their performance in academics, social life, and their mental health. In adolescents and teenagers, social media is doing more harm than good. Studies have shown that constant use can lead to physical sub-health and mental health challenges. This includes depression, distractions, anxiety, and suicide (Li et al., n.d.). It has been reported that users of social media are over-analyzing themselves against those who display themselves positively. It has been shown that individuals who compare their appearances, accomplishments, and abilities to those of popular influences develop depressive symptoms. These online platforms have also increased the potential risk of self-harm and suicidal thoughts. Research has found that many online interactions have shown increased intensity and frequency. Furthermore, these experiences have been associated with cyberbullying and cyber victimization (Nesi, 2020). For students, high levels of social networking engagement have led to major academic procrastination for college students, which has been reported by 70% of students. It has been shown that continuous academic procrastination interferes with academic achievements and stress levels (Xie et al.,



2023) Understanding the pivotal role of dopamine in the overlapping mechanisms of addiction and attention will allow us to evaluate the impact of online networking platforms on different age groups.

Conclusion

This paper aims to provide a concise cumulation of information on the involvement of dopamine and acetylcholine on attention span and how social media has changed our ability to concentrate. The evaluation of the impact of social media can expose more extensive cultural shifts and trends in communication that represent the generation's societal norms and behaviors. Research on the overlapping neural activity involved in reduced attention and addiction is limited as the onset of chronic consumption of short-form media is relatively new, having expanded greatly in the past few years. The brain activity during reduced attention is very complex and while new studies have been published on the impact of social networking platforms in general, further research should be conducted to fully elucidate the underpinning mechanisms behind this particular addiction and behavior. Furthermore, new studies could explore the impact of social media on attention spans. The impact of social media on our attention span has been rarely examined. In addition to the topics covered in this review, there has also been evidence to support the relationship between other factors such as GABA on reduced attention and how this affects dopamine levels. In conclusion, social media addiction is a novel area of research that is important to explore as our usage continues to increase. Abuse of this form of content can lead to serious mental health problems including depression, low self-esteem, and, in some cases, suicide. It is important to understand the neural mechanisms behind what makes social media, specifically, so addictive so that we can better inform intervention strategies for those most affected.

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