The Impact of Social Media on the Adolescent Brain: Cognitive, Emotional, and Societal Implications

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Abstract. This paper reviews the neurological and psychological effects of short-form social media on adolescent brain development. Drawing from neuroscience, psychology, and media studies, it analyzes how digital reward systems, attention regulation, and social validation interact with the brain's dopaminergic pathways and prefrontal functions. Findings reveal that short video consumption repeatedly activates the brain's reward circuit, leading to dopamine dysregulation, reduced sustained attention, increased impulsivity, and altered sleep patterns, which collectively impair cognitive control. Meanwhile, heightened sensitivity to social validation, peer approval, and online rejection among adolescents underscores their neurodevelopmental vulnerability, as these factors strongly influence emotional regulation and motivation. The study further explores both behavioral and societal consequences of excessive digital engagement, including potential addiction, emotional distress, and social comparison. It emphasizes the necessity of comprehensive educational programs, parental guidance, and societal interventions to promote digital literacy, foster cognitive resilience, and encourage balanced, healthy media use habits among youth in the rapidly evolving digital landscape.

Keywords: Adolescent Brain Development; Dopamine Regulation; Attention Span; Reward Circuitry; Neuroplasticity.

1. Introduction

In the past decade, short-form video platforms such as TikTok, Instagram Reels, and YouTube Shorts have rapidly reshaped global digital culture. Designed for speed, sensory stimulation, and algorithmic precision, these platforms provide users with endless streams of brief, engaging content that demand minimal attention yet produce maximal reward, affecting mostly Gen Z (born 1995-2009) and Gen Alpha (born 2010 and after) [1-4]. While their entertainment value is undeniable, a growing body of neuroscientific research has raised critical concerns about their effects on the human brain, particularly in terms of cognitive development, attention regulation, and emotional processing [3,4]. One major area of concern is the influence of short-form media on the developing brains of children and adolescents. Due to the high neural plasticity during these formative years, repeated exposure to rapidly shifting stimuli may impair the maturation of executive functions such as working memory, impulse control, and sustained attention [3]. Equally troubling is the emergence of the so-called brain rot phenomenon, characterized by cognitive fatigue, emotional blunting, and a decreased capacity for deep thought, which some scholars associate with chronic overstimulation from algorithm-driven content. [4,5] This paper explores the multifaceted neurological effects of short video consumption across different age groups, with a focus on neurodevelopmental vulnerability and cognitive overload. It also examines the behavioral and societal implications of brain fatigue in the digital age, drawing on recent findings from neuroscience, psychology, and media studies [6,7]. To understand these impacts more precisely, the following section delves into the neurological mechanisms underlying social media addiction, focusing on how reward circuitry, dopamine signaling, and motivational processes shape users' engagement and dependency patterns [1,8].

2. Neurological Mechanisms of Social Media Addiction

2.1 Reward Circuit Activation

When we are browsing social media, many short and concise videos and articles that provide timely feedback come into our view, thus generating a great deal of satisfaction. Research conducted by Cheng, a master's graduate in Psychology from Shanghai Jiao Tong University, and Zhao, an Associate Researcher at the Mental Health Center affiliated with Shanghai Jiao Tong University School of Medicine [1], has demonstrated that such reward stimuli are received and transmitted to the brain. Specifically, dopamine neurons in the ventral tegmental area are activated, releasing dopamine signals to the nucleus accumbens. Medium spiny neurons within the nucleus accumbent are subsequently activated through the action of D1 and D2 receptors, triggering reward-related behaviors and learning responses [1]. Furthermore, dopamine signals project to the prefrontal cortex, enhancing our sensitivity to reward behaviors. Concurrently, reward stimuli also activate the hippocampus, which plays a crucial role in the reward circuit by linking memories with reward behaviors [9-11]. The amygdala, as part of the reward system, receives input signals from the ventral tegmental area and projects to the nucleus accumbent, facilitating the formation of emotional memories. This comprehensive mechanism effectively explains the underlying reasons for our addiction to social media [12].

2.2 The Sunflower Seed Effect & Motivational Sensitization

The sunflower seed effect, a metaphor in psychology, illustrates that once people start eating the first sunflower seed, they can't stop [8]. Although it's just a simple action at the beginning, it's very difficult to stop later. Watching social media is a very simple task. Just moving your finger, you can switch videos. These processes do not need complicated operating or in-depth thinking; it is suitable for people of all ages. This kind of instant satisfaction that can be obtained without much effort can make people addicted [8,12]. In the field of drug addiction research, the behavior of addicts is generally regarded as having undergone a transformation process from purposeful instrumental use to uncontrolled habitual use. The ambiguity of the boundary between the rational use and problematic use of short videos may precisely be caused by the potential transformation of these two types of usage behaviors. The theory of motivational sensitization provides a comprehensive research framework of psychology and neurology to explain the process changes of addiction. In the process of information addiction, the behavioral motivation of this issue is activated by repeatedly performing information behaviors that the individual believes can generate rewards, thereby activating the want system of the brain. At the beginning, people regarded short videos as a tool for relaxation and leisure. However, during the process of watching videos, they repeatedly switched and browsed them uncontrollably, which eventually led to addiction. This process shows how a simple and seemingly harmless behavior can gradually develop into a habitual abuse that is hard to break, illustrating the subtle but powerful influence of instant gratification in daily life.

3. Psychological and Social Dimensions of Social Media Use

3.1 Maslow's Hierarchy of Needs and Self-expression

According to Maslow's hierarchy of needs, after people have met their most basic physiological and safety needs, they will pursue higher-level social needs, esteem, and self-actualization needs [3,6]. This framework is widely used in media studies: scholars say that social platforms and short-video apps satisfy people's needs of belonging and self-esteem through interactions, likes, comments, and fan following. This makes people more willing to continue participating, and it also explains why users always want to find more content to meet those higher-level stimuli. The brief and convenient characteristics of short videos have lowered the threshold for use. On short video platforms, there are no cumbersome operations or complex thinking. Everyone can be a producer, and people have the

opportunity to show themselves. They can generate and share their own content through editing. If their works gain success and attention, people will also get emotionally satisfied. In addition, many people are introverted and not good at expressing themselves or socializing in real life. However, they are eager to communicate with others. Short-video platforms offer a suitable social environment that is different from the real world. People can interact with others through following, sending private messages, commenting, and other ways. During the process of communication and interaction, people can easily resonate with certain content [3,11]. Satisfying one's higher-level emotional needs has led to an increase in the frequency and duration of using short-video platforms, gradually causing addiction.

3.2 Positive Effects

We found that there were a few positive effects of social media on our brains. But there are only two kinds of benefits to our brain when we use social media: Changing our memory and emotional support [7,9]. Through the research, we find the explanation that be shown in this essay. As you know, memory is a brain function that enables the encoding, storage, and recall of information, which is based on the need to complete a task or perform a kind of behavior. With the help of social media, the process of recalling memories, that is, retrieving previously stored past experiences by reactivating neural activity, has become more convenient [7]. A survey study involving 66 students from Cornell University highlighted how social media enhances the brain's memory capacity. The students were asked to record their experiences and rate them based on emotional intensity, then indicate which experiences they had shared on social media. After completing two quizzes spaced a week apart, the students demonstrated better memory of the experiences they had shared online, regardless of the emotional intensity ratings of those experiences. Through the research, we found that social media can foster a sense of belonging in us. In terms of emotional support, it helps to prevent mental health issues by bringing together people who have similar struggles, missions, and goals. Additionally, people share updates about their daily lives on social media. Even just simply being aware of others' life experiences, and even without direct communication, can also create a feeling of emotional support to us [9,11]. Through the emotional bonds, the pituitary gland at the base of the brain will release oxytocin, a stress-relieving hormone that generates a sense of protection [9].

4. Negative Effects of Social Media on the Brain

For the negative effects of how the short video can affect our brain, we have discovered that there are three main impacts on the human brain: Attention span shrinkage, Dopamine Dysregulation, and altered sleep patterns. Through the research and essay, we can discuss those negative effects one by one in detail.

4.1 Attention Span

Firstly, for the one who called Attention span shrinkage. A group of researchers called Pew Research claims that nowadays over 81% of teenagers and 67% of adults use social media in their daily lives [6]. With these technologies now everywhere, people are questioning how they might be changing our behavior and mental abilities. Some research even suggests that too much use could shrink parts of the brain linked to focus and concentration, which is called the prefrontal cortex [13,14]. We also realized that the attention of humans has been classified into 4 different types: sustained, selective, alternating, and divided. Sustained means the ability to concentrate on one stimulus for a long time; in addition, selective is the ability to choose to follow the stimulus. Alternating is the ability to change the mission between different cognitive stimuli, and divided attention shows the ability to carry out multiple tasks simultaneously. Sustained attention was once regarded as the most critical cognitive ability [3]. However, heavy social media users exhibit a significant decline in sustained attention, alongside increased alternating attention and divided attention. A study from the Technical University of Denmark found that social media is reshaping the

brain's attention-processing mechanisms while reducing gray matter responsible for inhibitory control, memory, language, and sensory perception. These neurological changes resemble the brain structure of individuals with attention deficit hyperactivity disorder (ADHD), a neurodevelopmental condition characterized by inattention, hyperactivity, and impulsivity [14].

4.2 Dopamine Dysregulation

When people engage in social interactions, their brains release two kinds of key neurotransmitters, dopamine and serotonin, which are responsible for transmitting chemical signals between the neurons [1,4,12]. The secretion of these neurotransmitters is closely linked to feelings of happiness and satisfaction. Research indicates that every like or positive comment triggers dopamine release, a neurotransmitter and hormone primarily associated with pleasure in the brain. As a motivational molecule, dopamine surges significantly during reward-seeking behavior, driving us to continually pursue rewards [1,12]. The insidious nature of social media likes lies in their classification as instant gratification rewards; they require no effort to obtain and have virtually no delay in their effects [12]. This type of reward is highly addictive to us, and through the research from Harvard University researchers, we can clearly see that they have found the amount of dopamine released upon receiving a like is comparable to that released when consuming drugs like cocaine. When rewards require no effort or delayed gratification, we develop a very strong dependence on them. To maintain the same pleasurable experience, we're compelled to scroll our screens endlessly between different social media - just like falling into a bottomless pit where only increased social media usage can sustain the effect, and this dependency gradually escalates into addiction. More critically, this process was fundamentally altering your reward circuitry, only to achieve the same dopamine release, you need to harvest increasingly more likes-creating a vicious cycle of neurochemical tolerance [12].

4.3 Sleep Pattern Disruption

The last negative impact we are going to look at is altered sleep pattern [6,8,12]. We just mentioned in the last paragraph that social media has addictive properties for humans. But more critically, the addictive nature of social media disrupts our sleep patterns, thereby impairing concentration and reducing our work efficiency [12,14]. The human sleep-wake cycle is regulated by melatonin, also known as a kind of hormone that controls our sleeping, which is released by the brain. The pineal gland in the brain is activated in darkness, prompting melatonin to enter the bloodstream. However, the intense light from social media or our phones suppresses melatonin secretion, which is inverting our circadian rhythm and also leading to poorer sleep quality [14]. Moreover, scrolling through Facebook, Instagram, or similar apps before sleeping will stimulate brain activity. This physiological and emotional arousal prolongs the time it takes to fall asleep. The pervasive and unrestricted negative impact of social media is exactly the root cause of sleep deprivation and its subsequent health problems [14].

5. Vulnerability in Adolescence

Concerns about the effects of digital media use on brain function and structure, as well as physical and mental health, education, social interaction, and politics, are increasing, particularly for adolescents, as their brains are still in development stages; they are more sensitive to information stimulation compared to adults [5,7]. Between the ages of 10 and 12, changes in the brain make social rewards, compliments on a new look or hairstyle, compliments from a classmate, start to feel a lot more satisfying [5,11]. Specifically, receptors for the happy hormones dopamine and oxytocin multiply in a part of the brain called the ventral striatum, making preteens extra sensitive to attention and admiration from others. According to Mitch Prinstein, Chief Science Officer at the American Psychological Association, social media activity strongly engages the ventral striatum, producing surges of dopamine and oxytocin during social reward experiences. Nearby, the ventral pallidum supports motivation and goal-directed behavior [5]. These evolutionarily older subcortical regions

underlie instinctive responses and reward processing. Part of what makes online interactions so different from person-to-person ones is their permanent, and often public nature, according to research by Jacqueline Nesi, PhD, an assistant professor of psychology at Brown University. After you walk away from a regular conversation, you don't know if the other person liked it, or if anyone else liked it, and it's over, stated Prinsten. That's not the case in social media [6]. Instead, kids, their friends, and even people they've never met can continue to seek, deliver, or withhold social rewards in the form of likes, comments, views, and follows. As children and teens increasingly go online for entertainment and connection, parents, scholars, and policymakers are concerned that young people's biology is making them particularly vulnerable to, and in some cases, even exploited by, social media [5,6].

5.1 Adolescent Brain Plasticity

Recently, cognitive neuroscience studies have used structural and functional magnetic resonance imaging (fMRI) to examine how the adolescent brain changes over the course of adolescence [7]. The results of several studies demonstrate that cognitive and socio-affective development in adolescence is accompanied by extensive changes in the structure and function of the adolescent brain. Structurally, white matter connections increase, allowing for more successful communication between different areas of the brain. The maturation of these connections is related to behavioral control, for example, connections between the prefrontal cortex and the subcortical striatum mediate age-related improvements in the ability to wait for a reward. In addition to these changes in white matter connections, neurons in the brain grow in number between conception and childhood, with the greatest synaptic density in early childhood. This increase in synaptic density co-occurs with synaptic pruning, and pruning rates increase in adolescence, resulting in a decrease in synaptic density in late childhood and adolescence. Structural MRI research revealed that the peak in grey matter volume probably occurs before the age of 10 years, but dynamic non-linear changes in grey matter volume continue over the whole period of adolescence, and the timing is region-specific. Interestingly, changes in grey matter volume are observed most extensively in brain regions that are important for social understanding and communication, such as the medial prefrontal cortex, superior temporal cortex and temporal parietal junction. There is evidence that the density of grey matter volume in the amygdala, a structure associated with emotional processing, is related to larger offline social networks as well as larger online social networks. This suggests an important interplay between actual social experiences, both offline and online, and brain development. Adolescence, which is defined as the transition period between childhood and adulthood (approximately ages 10–22 years, although age bins differ between cultures), is a developmental stage in which parental influence decreases and peer influences become more and more important [5,7]. Being rejected when communicating via digital media can be impactful to adolescents. Extensive research, including large meta-analyses, has demonstrated that social rejection in a computerized environment can be experienced similarly to face-to-face rejection and bullying, although the prevalence of cyberbullying is generally lower. In all, cyberbullying peaks during adolescence and a large overlap has been found between victims and bullies [6,11]. In part, this overlap could be explained by victimized adolescents seeking exposure to antisocial and risk behavior media content. The next subsections will describe recent discoveries in neuroscience on the neural responses to online rejection and acceptance [6].

5.2 Cyberbullying and Social Rejection

The Cyberball paradigm can be applied to play out the process of social rejection. This experiment is a widely adopted experimental tool in social and cognitive psychology for investigating the psychological and neural effects of social exclusion. Originally developed by Williams et al., the task simulates ostracism in a controlled, minimalistic virtual environment, allowing researchers to reliably elicit social pain responses in participants [6]. In the classic version of the task, participants are led to believe they are engaging in a virtual ball-tossing game with two or more other players via computer. Unbeknownst to them, the other players are pre-programmed agents. The participant's avatar appears

on the screen alongside the others, and during the inclusion condition, the virtual players distribute the ball equally among all participants. However, in the exclusion condition, after a few initial tosses, the participant is systematically ignored, with the ball being passed only between the computer-controlled players [6]. The Cyberball task has been shown to reliably induce feelings of rejection, lowered self-esteem, and decreased sense of belonging, which is the same feeling you get when getting rejected online, a common phenomenon occurring in social media today [6,11].

Using functional MRI (fMRI), researchers have found that after people are excluded socially, certain brain areas like the orbitofrontal cortex and insula become more active [6,7]. This might mean that being left out causes people to feel more emotionally upset or alert. Stronger activity in the dorsal anterior cingulate cortex (ACC) has been seen in teenagers and young adults who have been rejected before, experienced abuse, or had insecure relationships growing up. On the other hand, teenagers who spend more time with their friends show lower ACC activity when they are excluded, which might help protect them from the effects of being left out or cyberbullied. But since all these results are based on correlation, we still don't know for sure if the environment shapes the brain or if the brain influences how someone reacts to the environment. It's also possible that the ACC and insula light up not just because of negative feelings, but because something socially important is happening, since the same areas are active when people feel included, too. In other studies, when adolescents were left out in an online game like Cyberball, researchers noticed activity in the ventral striatum and subgenual ACC, and this is often linked with depression. So overall, being rejected seems to trigger brain regions involved in strong emotional responses. These findings suggest that teenagers might be especially sensitive to social rejection during this stage of life, which could be related to how the striatum and subgenual ACC are more active in adolescence [6,11].

6. Societal Implications and Countermeasures

In the current era background, when the Internet is booming, to reduce the negative impact of social media on people's attention and thinking ability, it requires the joint efforts of all portions of society and the proposal of practical and feasible countermeasures [4,5,8,9,12]. First of all, social media should guide users to rationally control their usage time. Time management tools can be used to limit the daily usage duration, or content filters can be set up to prevent users from getting addicted to low-quality and meaningless content [9,12]. Secondly, users' awareness of active input should be strengthened. Individuals should be strongly encouraged to enhance their thinking ability through reading, writing, thinking training, and other ways, turning from simple passive reception to active construction [9,12]. At the same time, it is also necessary to encourage public cultural activities and social organizations to provide more high-quality cultural events, such as libraries, art performances, lectures, exhibitions, and guide the public to seek more valuable spiritual sustenance beyond short videos. Finally, from a macro perspective, regulatory authorities and social media platforms should also assume social responsibilities, promote the production and dissemination of high-quality content, and establish mechanisms similar to addiction warnings to issue alerts when users browse for a long time, intervening in usage behavior at the institutional level [9,12]. Only when individual self-discipline and social structure work together can we effectively address the cognitive challenges in the Internet era and avoid the collective falling into the predicament of shallowness and brain corruption. For instance, China's anti-addiction system aims to curb excessive use of short videos by limiting screen time and restricting nighttime access. While Apple's Screen Time feature and Android's Digital Well-being tool help users monitor and manage their media consumption. These examples illustrate how governments and technology companies are responding to the trend where users continuously pursue higher levels of psychological satisfaction through digital interaction. Despite these control measures, many users still struggle to regulate their screen time, as the sense of social connection and validity provided by online interactions is often higher than the imposed limits. This reveals a paradox of modern media use: While technology works as a tool for self-regulation, it simultaneously deepens users' emotional dependence on virtual affirmation and belonging [9,12].

7. Conclusion

Rising engagement with short-form video platforms has been shown to alter brain function in ways that compromise cognitive health. Neuroimaging and EEG evidence reveal diminished prefrontal cortex activity and disrupted executive control among adolescents who frequently consume such content. These neural changes correspond with shortened attention spans, reduced tolerance for delay, and a growing dependence on immediate stimulation, patterns strikingly similar to behavioral addiction. The term brain rot is therefore not mere exaggeration; it captures the gradual erosion of neural resilience and cognitive coherence under sustained digital overstimulation. This phenomenon should not be viewed as an individual weakness but as a broader transformation in our cognitive ecology. In the modern attention economy, adolescents, whose brains are still in critical stages of development, are uniquely vulnerable to persuasive design, algorithmic feedback loops, and dopamine-driven reward systems. These mechanisms threaten emotional regulation, learning capacity, and the ability to engage in sustained, reflective thought. Future research should integrate longitudinal fMRI and behavioral studies to clarify how chronic digital exposure reshapes neural circuitry and self-regulatory function. Safeguarding the minds of the next generation will require cultivating digital and educational environments that strengthen attention, encourage deep reflection, and sustain cognitive integrity in an age of relentless stimulation.

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